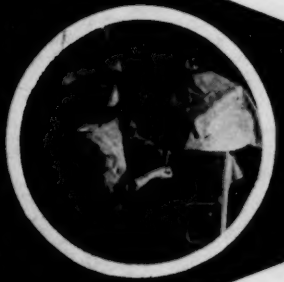
OR YEARBOOK



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O.R. YEARBOOK

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Foreword

This is the eleventh volume of the O.R. Yearbook from HOSPITAL TOPICS. Like the previous Yearbooks, it brings together in a permanent reference form the important material published in the O.R. Section of the magazine during the year. Again this year, as a service to our readers, we have included selected material from other sections of the magazine because we thought it was of particular interest to the operating-room staff.

Editorial material presented in the O.R. Section is selected and prepared by the HOSPITAL TOPICS staff. The guidance of Carl W. Walter, M.D., of the surgical staff of Peter Bent Brigham Hospital, Boston, and of Dorothy W. Errera, R.N., is gratefully acknowledged.

Gordon V. Marshall

Publisher

the O R

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Orienting Fourth-Year Medical Students to the Technics, Environment and Responsibilities of the Operating Room

By Rose Tashjian, R.N.*

Each year we have some 50 to 60 medical students from the Harvard University Medical School at the Peter Bent Brigham Hospital for their clinical experience in surgery. This two-month experience in a teaching hospital is required of fourth-year students, and the entire class is divided among the Massachusetts General Hospital, Beth Israel Hospital, and this hospital.

A number of the students in this category have had some exposure to surgery in their curriculum, since in their second year of medical school they can choose surgery and practice in the experimental laboratory. Though they are keenly aware of the difference between that exposure and the experience of working in an atmosphere created for the human patient, they are generally unaware of the factors that make up this special environment and the technics practiced within it.

An orientation program is planned by Francis D. Moore, M.D., surgeon-in-chief. As part of this program the nursing service in the operating room has the responsibility of orienting the students to the operating room.

We set aside time during their first day at the hospital for part of the orientation period in order to:

1. Familiarize the student with the role that he plays as an assistant to the surgical team in regard to the patient.

2. Guide the student in practicing good aseptic technic.

*Operating room supervisor, Peter Bent Brigham Hospital, Boston.

3. Familarize him with the policies and interpersonnel relations in the hospital operating room.

During this hour and one-half session in the operating-room suite, the following points are included by informal lecture, demonstration and discussion:

1. Introduction of the students to the operating room supervisor by the chief resident. The supervisor in turn presents her assistant and the operating-room secretary. This simple gesture enables the student to recognize those who can help him.

2. Explanation of the operating-room physical plan, including a tour of the operating-room suite, the recovery room, cystoscopy area, anesthesia area, the restricted and unrestricted areas. During this tour, there is a discussion on the psychological aspect of the preoperative patient and the nursing care of the patient during his postoperative period in the recovery room. Also, there is an opportunity to introduce these students to the nurses and other members of the operating-room staff and to inform them of the contribution of these persons to the function and management of the operating room.

3. Explanation of clothing policies. It is reiterated that students must change completely into operating-room clothing before entering the suite, and must wear conductive shoes which must be clean. Students are instructed in the use of the germicidal shoe bath and told that their shoes are to be worn only in the operating-room area, and left in their lockers.

The author demonstrates to a young medical student the correct technic for donning gown and gloves. Good operating-room conduct is stressed, and occasional air and mask samples are taken to prove that unnecessary conversation increases the bacteria count.

Above, the student observes the demonstration of the surgical scrub technic. Later he will be observed as he demonstrates the meticulous procedure for the evaluation of the instructor.

4. Safety practices. This portion includes instructions and reasons for wearing only cotton outer clothing (because other materials create static), and for caring for conductive shoes and making the daily check with the Conductometer to assure they are safe. Students are also acquainted with the electrical system with its ground detector, and with the technics described in testing the floors and furniture, which are checked for conductivity each month by the maintenance staff.

5. Environmental sepsis. The students are impressed with their responsibility to the patients in that they can be a source of possible infection. They are responsible for reporting any upper respiratory infection to the resident and the operating-room supervisor, who will see to it that they are given nose and throat cultures. It is also emphasized that dermatitis problems, open cuts, and lesions should be reported immediately.

In these and other ways students are made acutely aware that there is a standard; that they are going to be an important part of it, and must make specific contributions to seeing that the standard is maintained at the highest possible level.

6. Operating-room schedule. Students are shown where the schedule is posted and where to find their own names and informed of their responsibility for checking again before scrubbing to note any time change.

7. Individual responsibility. Covered in this discussion are the student's responsibility for aseptic technic; his responsibility to the surgeon and the patient on the table; his duties in cooperating with

other members of the team; the importance of promptness; time allowed for scrubbing and being ready for duty, taking into consideration the effect of delay on the patient's condition and the surgeon's state of mind.

8. Surgical scrub demonstration. Correct technic is explained and shown, and each student is given a copy of the routine followed in the hospital.

9. Donning gown and gloves. Correct technic is demonstrated, and an explanation of sterile areas is given.

10. Maintaining good aseptic technic. Once the students have donned gown and gloves, they are instructed in good operating-room conduct. Occasionally, air and mask samples are taken to prove that unnecessary conversation increases the bacteria count.

11. Septic cases. The students are told what cases are considered septic and their responsibility in these situations. Emphasis is given to the necessity for immediate isolation and sterilization of equipment and care of the room.

We have found that the time is most profitably spent in helping these students become acquainted with operating-room nursing, maintaining our standards, and accelerating their adjustment to the new environment.

Below, Miss Tashjian and student go over a copy of the routine followed by the hospital. A copy is given to each member of the orientation class, and each is expected to be letter-perfect in following it.

Mental Health in the Operating Room

By Grace T. Gould, R.N.*

A rich potential for mental health exists in the operating room. The O.R. offers a unique quality of human group experience to be found nowhere else in the hospital. For this reason I hope operating-room experience is never deleted from the nursing curriculum.

To some persons, the operating room is perhaps the last place they would expect to find mental-health concepts and their application. I believe such thinking is due to a stereotype of the operating-room area and the operating-room nurse.

In this stereotype, the operating room is supposed to be a mechanical, technical area, and the operating-room nurse is a person who possesses primarily mechanical, technical skills. My own experience has been that nothing could be farther from the truth.

To begin with, I don't believe you have to apologize for your technical skills. You need all of them. What would the surgeon, the anesthetist, and the patient do if you were not technically competent? Thank heaven you have these skills.

Furthermore, technical skills foster and are interrelated with human-relations skills. I have heard patients say: "I feel safer, just watching the way that nurse puts on her sterile clothes." And I remember the elderly gentleman who, while waiting in the induction room, looked through the open door into the operating room and was quite

*The author, a psychiatric nurse, is now employed by the Division of Mental Health, Department of Institutions, State of Washington. She was formerly a member of the faculty, Texas Woman's University College of Nursing, in Denton, Tex. This paper is based on a talk at the 1960 meeting of the Texas Association of Operating Room Nurses.

impressed by the efficiency of the busy people he saw. He said: "You folks sure seem to know what you're doing; you can put me to sleep now any time."

I think the technical skills are needed because they make the patient and the staff feel secure. But the fact that one has technical skills does not mean that one does not also have human relationship skills; and these interact.

For instance, you can go in and set up a *room* – or you can go in and prepare a room for the human beings who will live some of the most important moments of their lives in that room.

And doesn't it make a difference, when you are setting up the room, for whom you are setting it up? The wife of a surgeon? Your sister? The head nurse on a medical ward? Your next-door neighbor?

Mental health has to do with people. People are important; the people we know and the people we don't know. Basic to everything that we would talk about in terms of mental health in the operating room is our concept of man. Who is he, and what is he? Who is the patient, and the patient's family?

The operating room is a good place to learn anatomy and physiology. It's also a good place to learn profound respect for the human being and the human body.

I remember hearing a nursing student complaining about mopping up some blood on the floor. She thought this was the job of the porter, who was off that day. I guess she didn't consider the job worthy of her. I said, "You know, that's human blood you're mopping up – not a pig's or a cow's blood. The specimen that you carry to the lab; the lining of a uterus after a D&C; a phalanx of a finger, an arm, or a leg – these all belonged to a human being; they were once part of him. If you believe a human life is sacred, then this specimen is sacred, because God made the person and the specimen."

You handle specimens differently when you feel this way, and you help those who are working with you to handle them differently when they see your example.

Mental health actually begins with a deep, reverent respect for the person, and for all parts of him. If you love someone, every hair on his head and every pore is precious and important to you. Why do you think people save baby curls? And everybody we take care of is precious and important to someone. They may not be wives of directors on the board, but they're all "V.I.P.'s."

For the first time we feel very hopeful about reaching this goal of mental health. And you in the operating-room have an enormous opportunity for prevention of mental illness. We know that

a person's past experiences very much affect his present experiences. We know that what happens to us in the present affects the future. In the continuum of living it's hard to know where the past and the present and the future begin and end. But here's your opportunity.

First of all, what happens to the patient and his family and to the staff; to the operating-room team; to everyone concerned? We're not interested only in the mental health of the patient and the family. Your mental health is important, too. You have to be in quite good condition to work as hard as you do, and you have to be reasonably comfortable and happy, or you can't create a comfortable environment for other people.

Did it ever strike you that you can break into the vicious cycle of the past, the present and the future?

If we are today what our past has created us, then we're victims of our past. If what happens to us today determines how we react in the future, then the present is the only hope you have for change, for modifying behavior, for attitudes. This is the rationale behind all preventive medicine. What we do today can modify the trauma of yesterday and prevent some of the trauma of tomorrow.

We know this about mental illness: people get mentally sick or sick in any way because of the things that have happened to them, because of the experiences they've lived through – maybe from the moment of conception to the present.

Treatment and cause are related. If you're sick because of the experiences you've had, doesn't it seem logical that you can get well because of the healthy experiences you'll have?

This is where there is a great opportunity, in the operating room, to intervene in the present. Did you ever stop to think how little the operating-room schedule or bulletin board tells you about the situation or the person? It gives you the room number; the surgeon's name; the anesthetist's; the name of the operation; the patient's name. But how much does it tell you about anybody whose name is mentioned? And about anything that's going on? Did you ever stop to think that only the name of the operation is the same? That one cholecystectomy to you may be another thing to me?

There's no such thing as routine surgery. Surgery interrupts anybody's life routine. There's no such thing as minor surgery, either. It's all major, if it's being done on *you*.

How little that board tells you. It doesn't tell you that the surgeon's wife is in labor in the OB department that morning – and he's supposed to be calm, cool and collected. Nor does it tell you that the circulating nurse or the scrub nurse has dysmenorrhea. It doesn't tell you who was on call all night; that it may be the first scrub for

the day shift – but it's the last one if you've been there all night!

It doesn't tell you a great deal about the patient. Incidentally, it's just as easy to learn his name as the name of his operation. You don't have to learn 15 or 20 names like someone in a ward. There's going to be only one patient in this room; you should learn his name as you learn the name of your surgeon and anesthetist and your circulating nurse.

It doesn't tell you what kind of night that patient had. Perhaps they gave her a Seconal at 9 o'clock, and then woke her up for the physical, and woke her again for the "prep."

There are no small operations or minor operations when it's you or someone in your family. Have you ever watched a nurse on the O.R. staff change when someone she knows well is having surgery? She is especially concerned with the sterile field and the drapes and the light; hopes to get a certain anesthetist; wants a certain nurse to circulate and another one to scrub.

The board doesn't tell you about the family of the patient. It doesn't tell you who the patient is and what he does; what kind of year he's had; whether he lost his job before surgery; whether this is the fifth in a series of operations, and he's so tired of all of these surgical procedures.

It doesn't say that he just got over another serious illness and before he could get on his feet again he came down with this! It doesn't tell you about all the things he's suffering from or the kind of person he is. He's just a name on a board.

We look at patients as though they arrived by spontaneous combustion; as though they were always patients and always will be patients! Where were they before – a day before – a week ago? What will they be afterward? How does this episode fit into the total life experience?

Maybe you can't, in your situation, know the patient before he comes up, or know his family. But isn't it comforting for the patient to see a familiar face. It's satisfying to be able to say, "I'll be here when you wake up." This is reassuring, too; it implies he's going to wake up.

Patients have many fears that are quite natural. One which anybody facing any kind of surgery has is the fear that maybe he will die.

Those of us who aren't in the operating area have the greatest respect for operating-room nurses. We don't know how you even keep up with the new technics; the new equipment; the new machines, the new ideas, the new procedures.

Years ago, who ever thought we'd be operating on an open human heart? But one thing that isn't new, that hasn't changed, is the human heart. We're doing new technics but on the same human

body. Operating-rooms and operating-room procedures have changed dramatically and been revolutionized in the last 5, 10, 20 years – but the babies born today are the same kind of flesh and blood that they were 20 years ago!

We're working on the same old human body – and even with all of our marvelous technics there is still the possibility that the patient won't pull through.

There are also people who fear that maybe they will live! Some people with a malignant or terminal process hope they won't pull through.

Then there are two opposing fears which usually co-exist. First, the patient has a fear of pain, and a fear of expressing suffering; a fear of not "being able to take it" and a fear of not "being tough enough."

Patients are afraid that maybe they won't be "knocked out enough," especially with a local; that suddenly they're going to feel pain, sharp or excruciating pain for which they may not be prepared, or that perhaps a spray of Novocain isn't going to get down deep enough.

Then there is the fear that co-exists: that they will have too much anesthetic – that it will be so deep that they won't wake up. This is related to the fear of death and also to a fear that many may have in surgery – loss of control, being totally and completely dependent on other people who are usually strangers.

The O.R. is a strange world. For you who work in it, the green or the white gown, and a certain kind of shoes, and the lights and the instruments and the noises, are commonplace, everyday. But this is a strange world, a bizarre world, even for a very sophisticated patient. After he has passed that swinging door into the operating-room suite, he is separated from people he knows and loves and they're separated from him. He's alone, and defenseless, with strangers.

Another erroneous idea, I think, is concerned with preoperative medication. We feel rather sure that the patient is comfortable because he's had preoperative medication, but he's not moving much and he's not talking much. He's quiet.

Some patients are comfortable, and some are not. For instance, I remember seeing patients who wanted to ask a question, but because they were slowed down because of preoperative medication they couldn't quite formulate it. But it was in their mind, and then later they didn't know whether they said it out loud or just thought it.

A patient told me that when she had a "spinal," about 10 years ago, she heard the surgeon say, "See, I got in the wrong place, I'll have to try again." The thought vaguely went through her mind that maybe she could be paralyzed or something, from the way it sounded.

This was not a deliberately cruel or mean thing to say; it was thoughtless but very natural, because most of the patients the O.R. team works with are unconscious patients. Because surgeons and operating-room nurses are used to patients not being consciously aware of them, often it's natural to treat the conscious patient as though he were unconscious, or to give much too much credit to the effectiveness of preoperative medication; to think that he's not quite with us, that he's not really listening; not really absorbing the stimuli in his environment.

We've learned that sounds may be exaggerated, things may seem more bizarre; that the patient is suffering more but often isn't able to talk about it or to move.

In many hospitals patients are anesthetized in an induction room and never are in the operating room when they are conscious – but this does not happen everywhere.

Patients have described a feeling of helplessness, of being strapped down. One patient said, "Why, I almost felt crucified. Here I was with the IV and I was stretched out and I couldn't move; I never felt so helpless in my whole life! But you know, something wonderful happened. The nurse who was walking around the room took the time to hold my hand for those few seconds until I fell asleep."

It was only a few seconds. And she never released her hand until she felt the patient's hand let go, and she knew he was asleep. You might think that wasn't important nursing care. But that patient will never forget that nurse as long as he lives.

We have an erroneous idea in nursing that to do anything big or effective we have to spend a lot of time with a patient. As students, we think, "Well, after we do this procedure, we'll talk to them." After we meet the physical needs if we have a couple of minutes left over we'll throw in some of the emotional needs!

You don't have a lot of time in the operating room. You are the busiest group of nurses I know anywhere! You scoot; you run; you look as if you're on roller skates or maybe wings. You move fast and work fast. Time is a luxury you don't have.

An O.R. nurse may say, "You barely clean up one room and they move the next one in! I haven't even opened this pack yet! What do they think I am, twins?"

Or the circulating nurse: "I'm covering two rooms! I need roller skates!" Maybe it's three rooms, or more. However, you don't need a lot of time for a mentally healthy environment in the operating room. It takes only a second to wink, to smile, to pat the foot of the patient waiting

on the stretcher outside, or to look at him and say "Hello! Good morning!" Let him know what's going on. You're not going to get into a big conversation with him. It wouldn't be good for him. You want to keep him quiet. Besides, you don't have time. But you can say, "Did you get any rest last night? How are you this morning?" Maybe you are wearing sterile gloves – you can still wave good morning!

The idea is to let him know you're not just interested in instruments, you're interested in *him*. And you're getting the instruments and the room set up in good shape *for* him, because you want things to be safe and secure.

You're not doing it just to keep on developing manual skills, to see how dexterous you are; how fast you can do it. It's not a game. You're doing it to protect him – to protect his family.

Incidentally, you know, surgery is hard on the families. They didn't get any preoperative medication; they didn't have a Seconal the night before. They're facing it cold; they're getting this experience straight. Do you know how long it is when you wait? Look at their faces as you come through the door: "How are they doing? How much longer?"

Time's going fast for you; you're working hard, you're passing, you're doing a thousand things at once and thinking of what you're going to do next. But they just stand and watch the hands of a clock go around. And they pray: "Just let him pull through! I don't want to raise three children alone." Or, "They're supposed to be real good now. I wish I could have talked to the surgeon before they started." Or, "If anyone would just come out and let me know! Even to know that they're in; or if they're closing, or how much longer."

They're afraid to even go to the bathroom – for fear that while they're away someone may come out to give them a report!

I have said to relatives, "It's going to be a while yet and everything's going fine – why don't you go down to the coffee shop and get a cup of coffee?"

And their answer has been, "But, if they come out while I'm down there they'll think I've gone home!"

I have known people who wouldn't sit down for fear they would be out of the line of vision of the people going and coming through the O.R. suite!

We say: "The patient is a family; and the family is your patient." This "patient" is having a rough time because it isn't getting much pharmacological assistance; therefore it must get emotional assistance.

Moreover, our operations are taking longer now. We didn't used to have someone under surgery

from five to eight hours; now we do. But have we thought that the relatives are waiting a lot longer now than they used to wait?

Have you looked through the little window into the recovery room? You feel as though you want to go through it, and cover a patient with the sheet, and hold a restless patient, or be there when the patient wakes up.

Many hospitals have worked out some understanding and exceedingly kind ways of communicating with families during surgery. The kind of communication they have has a lot to do with the mental health of family members as they go through this experience. How will they feel about future surgery? Will they want to come back to the hospital?

Many persons put off operations at the cost of their lives because of unfortunate previous experiences. I've heard people say, "No more surgery for me!" To the warning, "It's a little tumor now, it's nothing; if you wait it may cost you. . ." they answer, "Well, I don't *care!* No more surgery for me!"

But if those persons could come in and have a first-rate human experience, they could face surgery again in the future, and could help others to face it.

Look at the implications for health teaching, if these persons told others, "You ought to go to that hospital; those people know what they're do-

"You have been impartially selected for our executive training program."

ing! They were nicer to me than anyone has ever been before!" Other people who had feared surgery might be influenced to get health services – to be hospitalized – to dare to have surgery!

But mental-health concepts are not just for patients and families. They're for everybody. Unfortunately, we may try to apply these concepts with patients but not with each other.

Do you know how the other members of the team are feeling when they come to work? Take the surgeon. It's one thing to hand a scalpel; it's another to use it. When you've made an incision in a human being from here to here, and somebody's insides are staring you in the face – no matter how many times you've done it, it takes something out of you. It's rough! You have life-and-death responsibility.

We have stereotypes for surgeons, too. The surgeon is supposed to be "temperamental." And if he is, he may have good reason to be.

One approach for dealing with the surgeon's temperament may be the way a mature, experienced nurse replied to a surgeon who was issuing a tirade that would have made a Marine blush. She knew this surgeon almost as well as she knew her own son. She said: "Honey, you just go ahead and swear, if it makes you feel better."

Then there is another possible reply to this kind of explosion: "It's been a rough morning, hasn't it; you didn't get much sleep last night either." Suddenly the surgeon thinks, "Well, they understand a little bit; they know I'm blowing off steam. They aren't taking it personally."

If you can do this for him, there might be a day when you can let off a little steam too! "They're always late! Where is everybody? Who do they think I am, quintuplets?"

Then he can say: "Are you getting any more help? Did that requisition come back with what you want? Anything I can do to help?" Support begets support. It's contagious.

Many other nurses envy operating-room nurses. Some of them see you as leading a very glamorous life. But what they envy most, perhaps, is your close contact not only with patients but with staff. Nowhere in the hospital, perhaps, is the team more of a reality. You literally touch the elbow, the side, of the physician, the surgeon. There's no doubt that you're a team. You're all in the same room together; you have the advantage of proximity. You're physically close, and when you're physically close it's easier to be psychologically and emotionally close. It's easier to understand each other, to know what people are thinking and feeling and to be able to meet their needs.

I think sometimes other nurses envy you the fact that when the doctor puts his hand out, you put

the instrument in it. You're *that* close. You do it without even thinking.

Some nurses today are very dissatisfied because they've gotten so far away not only from the bedside of the patient, but from the doctors. We aren't even making rounds with doctors any more in some hospitals. They make their rounds and we make ours. It used to be that the physician always had the nurse at his side.

I believe that that is where nurses want to be. Traditionally, that's how our profession came into being: "to assist" the physician; to be there when he needs us; to support him, to comfort him.

Can it be that we've become so independent that we almost resent the physician's intrusion in our nursing work?

Perhaps you don't face this problem in the same degree and extent that people face it in the wards; you're close to the doctor. You are a real team; you are giving students and staff an opportunity to learn group skills that they could not learn in other ways.

Where else do you get *this* group of professional people working together with the same patient—for this long a period of time – with this quality of human group experience and teamwork?

This can be a growing experience; a reassuring experience – because mental health is very much concerned not only with the individual but with the group, and with group living, and group working together.

I think that you in operating-room nursing have given the rest of us a very shining example of loyalty. For the most part, you may get furious with anesthetists and surgeons, but no one from any other part of the hospital had better say a word about them! *You* can criticize them, but no one else can – just as we can talk about our own relatives – but no one else had better. You are loyal to the physician, and I think he is loyal to you. You have a rapport that I believe many of us in other places wish we had. I think there are good reasons why you have it.

Patient, nurse, O.R. team – all want and need mentally healthful experiences – and they are to be found in the operating room.

Challenging New Study Made Of Traditional O.R. Practices

By Alice R. Clarke, R.N.*

In August, 1958, Maurice D. Wolfe, management engineer and assistant administrator of The Jewish Hospital of St. Louis, embarked on a managerial study of the operating-room department as one of a series of studies he is conducting on all phases of the operation of this progressive hospital.

By the end of 1959, with the study completed, industrial engineer Wolfe came up with some thought-provoking, if controversial, conclusions and recommendations that could significantly alter the staffing, supervising, and scheduling patterns of operating-room departments in large hospitals, if generally adopted.

Purpose of Wolfe's over-all study, according to his report, is to find methods to furnish the best patient care at the lowest possible cost. His purpose and *modus operandi* for this phase of the study are variously stated by him but, in substance, are: (1) to bring about the more efficient performance of operating-room personnel by coordinating efforts with the operating-room department and between operating-room personnel and other departmental personnel involved with servicing this department; and (2) to develop a better system of cost controls in an effort to operate the operating-room department in a more businesslike manner,

*At the time this article appeared, Miss Clarke was consulting editor of HOSPITAL TOPICS.

while respecting the needs of all professional groups and individuals.

To reach these objectives, it was necessary for an intensive study to be done by the hospital's management engineering department, of all the physical facilities in the operating-room department and the divisions and departments impinging on the operating-room service, such as: the division of surgery, the anesthesiology department, the recovery room, central supply, housekeeping, administration, and nursing.

Spiralling hospital costs and the reluctance to increase hospital rates made it extremely important, writes Wolfe, to set up some kind of cost controls, as well as to find ways to use existing facilities more economically, without jeopardizing the quality of patient care. While observing the current practices, Wolfe and his research staff kept alerted for practices which might shed light on mounting costs and any marked indications of departmental inefficiencies. Their goal was not to find out about the *status quo* only, but to devise and recommend a managerial system which would check excessive expenditures and introduce more efficient methods into the operation of the department.

Wolfe reports that to determine what controls were necessary and how such controls should be set up, he and his staff analyzed when and how the 11 operating rooms in the study were used; how and by whom they were staffed; and the system by which each operative case was scheduled for surgery.

Following this analysis of 5,753 operations performed in 1958, they did a cost breakdown of the total expenditures charged to the operating-room department. Every item and purchase of the department that could be was identified, analyzed, and proportionally allocated to all of the operative procedures undertaken during the year under study.

This systematic approach to cost-per-operation resulted in the discovery of a wide discrepancy between actual charges and actual costs to the hospital and revealed a monetary deficit of over $100,000 in the operation of the department.

While studying the department's existing scheduling system for both major and minor surgery, its staffing and supervision patterns, and the usage of the operating rooms during each 24-hour period, Wolfe found: an operating-room nursing staff too large for the number of operations performed; understaffing during the morning hours, overstaffing in the afternoon; overuse of operating rooms in the morning hours, and negligible use in the afternoon, evening, and night hours. This was true of both the operating and anesthesiology staffs. He observed that over 85 percent of operations were performed between 7:30 a.m. and 1 p.m., which required the department to be staffed with the

largest number of personnel working at top speed in the morning, while in the afternoon there was not enough work to keep the staff busy.

One finding, which on the surface would appear most laudable, was that all—surgeons, nurses, technicians—who were involved in the study were concentrating on one single function—patient care. And, according to Wolfe, they were succeeding in giving the finest of patient care. However, he protests without censuring, that administration, which is responsible for the costs and efficient operation of all departments in the hospital, had little voice in this department's expenditures for supplies, personnel, or operating-room usage.

With an administrator's eye on costs, and an industrial engineer's mind for methods analyses, Wolfe, in his recommendations, attempts to reconcile these two interests.

Maurice D. Wolfe, author of the report, is management engineer and assistant director, The Jewish Hospital, St. Louis. He is supervisor of maintenance, housekeeping, laundry, industrial engineering and personnel. A graduate of the London College of Engineering, London, England, he taught industrial engineering at the University of Louisville, Louisville, Ky., and has been a consultant on cost controls and standards as they relate to hospital management.

The solution, he suggests, is to increase room usage without increasing personnel. This can be accomplished, according to Wolfe, by adopting a more flexible scheduling system for operations that would permit a more economical utilization of operating-room staff. By more flexible, he means, one that would enable greater use of the rooms over a longer period of time, especially over an eight-hour period. He states that the current practice of top-heavy morning schedules has resulted in costly inefficiencies.

However, to make a recommendation for a revision in scheduling is one thing; to accomplish it is another, for it entails a complete departure from the traditional way of conducting an operating-room department.

Wolfe points out that to obtain a more flexible scheduling system requires that the supervisor in charge of the operating-room suite be delegated sufficient authority to interpret the policies of the chief of surgery, and at the same time, be able to govern the operating schedules to use rooms and personnel to maximum efficiency, without disrupting the interns' and residents' surgical experience on the clinical services.

At present, according to Wolfe's findings, there is no one with this kind of authority to perform

this function. The operating-room supervisory personnel either lack the authority or fail to realize the extent of their authority to carry this out.

Because operations must be scheduled, delicate working relationships develop among individuals staffing the scheduling office in the operating-room suite, the admitting office, and individual surgeons, Wolfe observes. Also, a rather rigid room-scheduling pattern is set up which results in delays in the operating schedule on frequent occasions. During this study, Wolfe found that the O.R. administrative supervisor could keep the department running efficiently up to a point, but that she did not have, and did not believe she had, sufficient authority to offer a visiting surgeon a room assigned to clinical service, even when the room was free.

Wolfe questions whether the traditional position of the nurse supervisor, and its divided responsibility to a director of a professional service and a director of nursing, is suited to the present complex, technical, and expensive operation that characterizes a modern operating room.

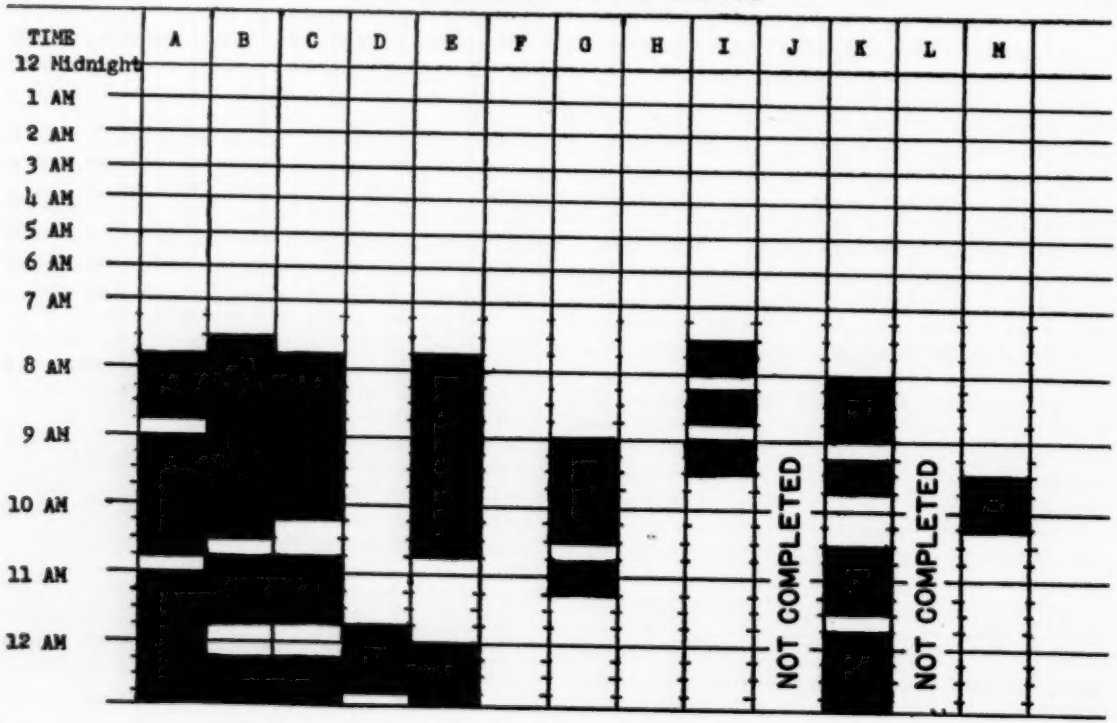
In describing the operating-room department hierarchical structure or chain-of-command, he notes: The direction of the professional activities of the surgeons and the assignment of cases to rooms rest with the director of the division of surgery. The responsibility for provision of nursing personnel, instruments, and environmental sanitation rests with the director of nursing. In immediate charge of the operating-room suite is a nurse supervisor who, traditionally, reports administratively to the office of the director of nursing and professionally to the director, division of surgery.

Neither the chief of surgery nor the director of nursing, believes Wolfe, has the background or time to deal with problems of control of personnel, supplies, and equipment, or can handle the needs of individual surgeons, relations with other hospital departments, and a host of other details that are essentially the responsibility of administration.

Although Wolfe contends that the operating-room department as it is now functioning is overstaffed with nursing personnel, he reports that the O.R. administrative supervisor, as she now performs, can barely keep up with the day-to-day duties and reports for which she is responsible, due to the constant demands from visiting surgeons.

The supervisor of the operating-room department at The Jewish Hospital of St. Louis is responsible for supervising and assigning the nursing-service personnel, including the 15 graduate nurses, a varied number of student nurses, seven surgical technicians, five student surgical technicians, three orderlies, and various aides. The administrative supervisor requisitions and maintains adequate supplies and equipment and all correlated functions. She controls schedules insofar as she can, and

OPERATING ROOM USAGE



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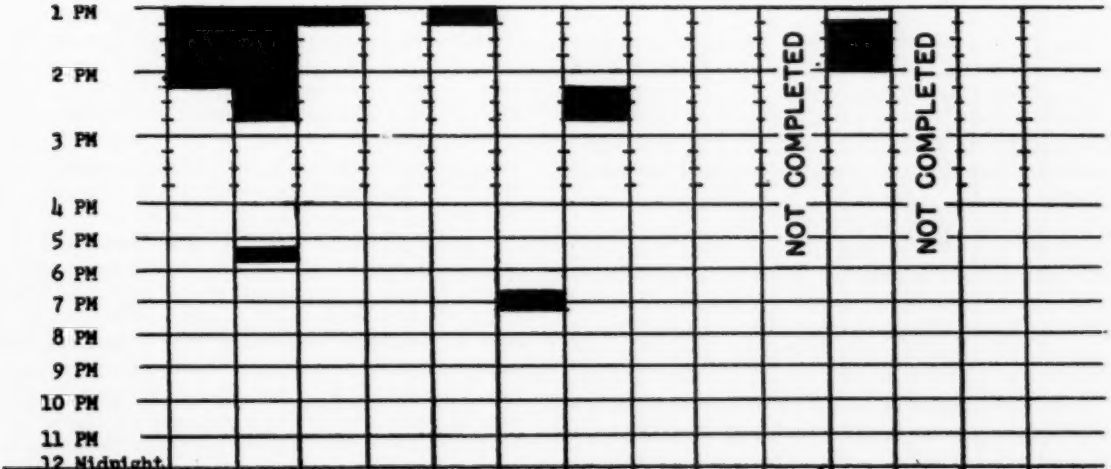


NUMBER OF OPERATIONS	3	4	3	1	2	1	3	0	3	/	6	/	1	27
ROOMS OCCUPIED 7AM – 4PM	360	390	270	60	255	0	150	0	90	/	270	/	45	1890 / 5940 MAX.
ROOMS OCCUPIED 24 HOURS														32%

interprets administrative directives to the nursing personnel. She studies all technics and setups used in the department and makes recommendations for improvements in the use of supplies, time, and patient care.

Wolfe reports that the individual in this position during the study was a qualified operating-room nurse and supervisor, but that her skills could have been more advantageously used and she could have better fulfilled the responsibilities for which she was prepared, if her duties as an O.R. supervisor and her duties as an administrator had not been combined. He states that this resulted in failure to complete either assignment well.

From what Wolfe and his team have observed, he concludes that someone in the operating-room department must have complete control of costs. He is of the strong opinion that this individual cannot be the O.R. administrative supervisor because she does not make out *all* the requisitions. Only those requisitions for routine supplies go through her, states Wolfe; other than routine requisitions are processed through the office of the director of surgery.

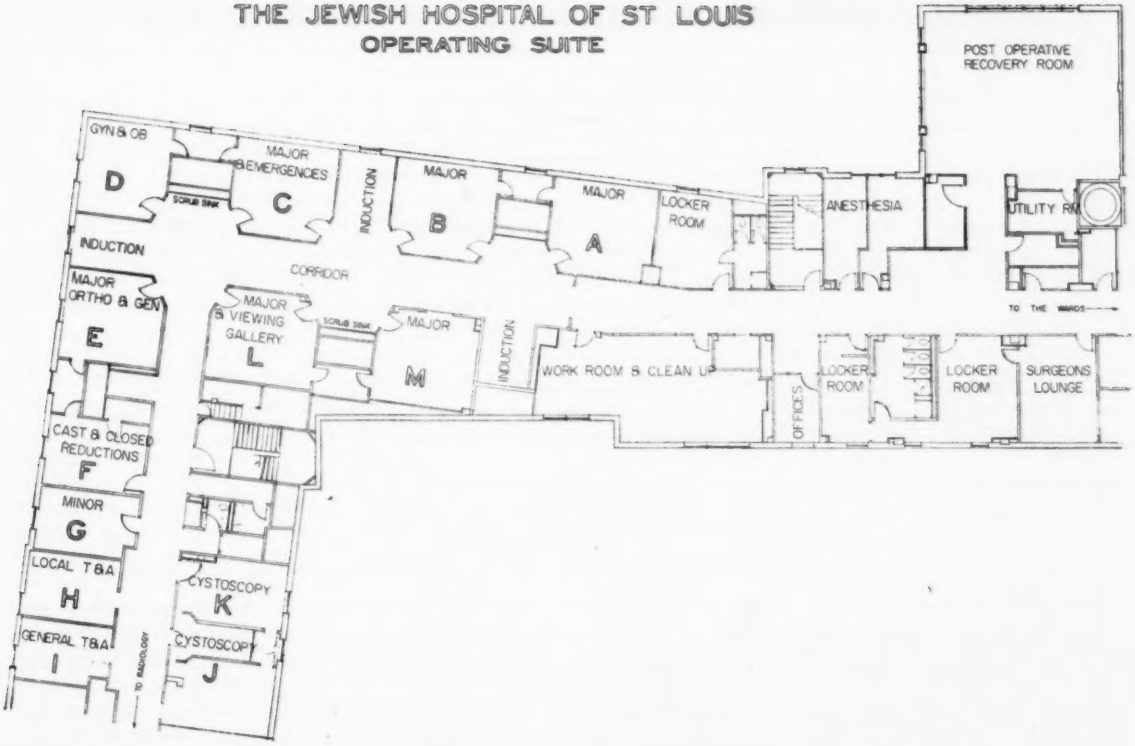
However, Wolfe writes that he discovered that neither source has any idea of the costs of these supplies or equipment, nor keeps a complete record of purchases and prices.

Apparent to Wolfe was the lack of a clear and definable line of authority and the delegation of that authority from the chief of surgery to the operating-room supervisors. He describes as unenviable the position in which operating-room supervisors are placed. As nurses, he writes, they are directly responsible to the director of nursing. But as operating-room supervisors, they are answerable to the chief of surgery. Also, they are at the beck and call of all the visiting surgeons, with the result that a significant portion of their morning time is spent answering calls and running errands. He concludes that administratively all of these factors are costing too much to be ignored.

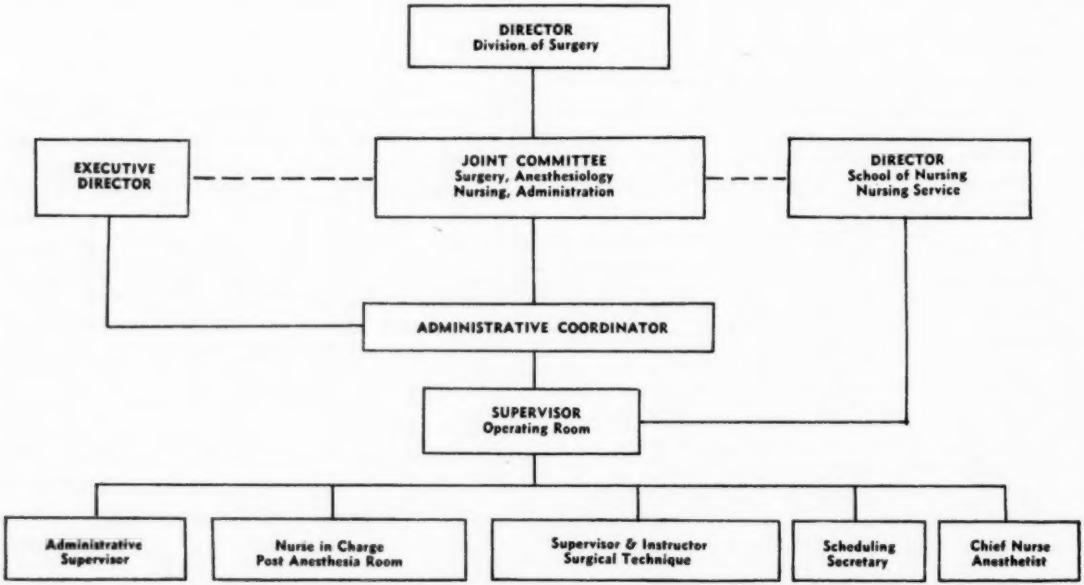
Is there a solution to this professional-administrative dilemma? Wolfe believes so. He recommends that a person be appointed to the operating-room department with the title "administrative coordinator" or "administrative supervisor"—titles he uses interchangeably. He suggests that the administrative coordinator be given the authority to supervise all functions carried out in the operating and anesthesiology departments with the objective of attaining the greatest use of operating rooms and operating personnel. (At one point in his report, he refers to this position as being filled by a lay coordinator but makes no further references to this as a recommendation.)

To help the administrative coordinator to carry

THE JEWISH HOSPITAL OF ST LOUIS
OPERATING SUITE



OPERATING ROOM DEPARTMENT ORGANIZATIONAL CHART



out these stated functions, Wolfe proposes the appointment of a joint committee comprised of three representatives—one from the division of surgery, one from the department of nursing, and the administrative coordinator, representing administration. These three would have the authority to resolve questions of policy and matters concerning their respective departments.

Originally, Wolfe had described the first two representatives as coming from the assistant director level, but later he verbally amended this recommendation, stating that they should be the chief of surgery and the director of nursing. He believes now that this would give the operating-room department true representation in nursing, anesthesiology, surgery, and administration.

In his mind's eye, Wolfe envisions the administrative coordinator giving administration a clear, unbiased monthly report of the operating-room department activities; acting as a control on expenditures for supplies and equipment; tranquilizing high-spirited operating-room personnel; raising the staff's collective morale; and by so doing, offsetting the administrative expense of the additional salary required for the newly created position.

The job description of such a position might read:

- Controls all administrative services of the operating-room department, and through the director of surgery, controls the surgical schedules so as to make the most of room availability.
- Checks the daily operating reports.
- Is responsible for the daily charting of the room usage.
- Processes all requisitions and effects savings in purchases of supplies.
- Investigates better usage of materials and supplies.
- Handles relations with other hospital departments which are related to the O.R.
- Works with two other people with sufficient authority to resolve any problems which arise regarding policy or procedure.

In essence, Wolfe's report on his study is a persuasive argument to support his belief that increased flexibility in operating-room schedules, more stringent cost controls, and better utilization of operating-room personnel are needed to substantially reduce the operating-room department's monetary deficit.

To illustrate the advantages of his proposal to revise the surgical scheduling system rather than reduce the number of nursing personnel, Wolfe cites these comparative projected figures: To reduce the operating personnel by two staff nurses would result in a saving of $7,000 a year, whereas by increasing room usage by 10 percent, it is possi-

ble to realize at least $25,000 saving a year. And, if his recommendations were adopted in toto, it would be possible to increase this amount to approximately $50,000 a year. According to his theory, a revised scheduling system would result in more available room space, 2,000 additional operations a year, and better utilization of personnel, and would practically eliminate the departmental deficit.

Wolfe's efforts to substantiate this prediction take up a considerable amount of the 90-page report on his completed study. His strong opinion, based on the findings of this study, has led him to propose the elimination of the top-heavy morning schedules that appear traditional in the majority of operating-room suites and to distribute the operating-room case load more evenly. He also recommends more equitable operation charges based on cost standards set up by him after his analysis of room usage and personnel utilization.

Wolfe is of the opinion that with 100 percent room usage over an eight-hour day and a 40-hour week, the operating-room department would realize a saving of $96,640.44 a year, plus added income from the extra operations that could be done. He optimistically adds that even if this figure were split down the middle, there should still be an expectancy of 75 percent of the standard, which would realize a saving of $48,320.22. The department accrued a deficit of $126,223 in the year 1958.

Methodology and Findings

To determine the exact usage of the different operating rooms at the Jewish Hospital, the management engineering research team, directed by Wolfe, studied all of the rooms for a 60-day period. Data gathered for 30 of those days were charted on graphs.

The first undertaking was a regular time study of the time necessary to clean each room and make it ready for the next operation. Other studies on actual times of operations and reasons for delay utilized standard daily forms, designed specifically for the purpose.

When completed the daily form gave the following information:

1. Description of the operation performed
2. Time patient entered operating room
3. Time operating group was ready
4. Time anesthesia was started
5. Time operation was started – first incision
6. Time operation was finished – closure
7. Time patient left the operating room
8. Reason for delay.

Another form used was simply a modification of the over-all O.R. schedule; four extra columns were added. In these four columns the recorded times for the completed operating-room schedule were listed, and charted each day by the management engineering team. After a 30-day period, data were transferred to a composite chart which made it possible to visualize 30-day room usage. From these charts and forms, the data obtained were charted on a separate sheet, and the actual times of operations, delays, and other pertinent information were determined.

By means of these time studies, the usage of the operating rooms was demonstrated fairly accurately, as were the hours vacant and hours available for usage.

From the professional services report, the figure of 5,753 operations performed in 1958 was obtained. Using the completed studies, the management engineer and his staff determined the number of each type of operation performed, the number performed in each room, the average times for the different types of operations, and the percentages of the total operating time. With these results, they were able to determine the average amount of times that each room had been in use during the year under study.

To set a standard or an average time for each operation, the research team studied 256 major operations. To arrive at an equitable available time during which the operating rooms should be in use, delays, changeovers, and other recurrences, including personnel fatigue and personal allowances, were also studied.

As a result of this study, the team deducted 30 percent, or 144 minutes, from the base on which the study was predicated – an eight-hour day or 480 minutes per day. This was to allow for these inherent delays which they found a part of every eight-hour period. This left 70 percent, or 336 minutes per day, for room availability. Wolfe and his staff accepted this as the maximum in room usage. Therefore, for their purpose, 336 minutes rather than 480 minutes per day was the 100 percent base for figuring room use.

In order to evaluate this on the basis of the year's operation, Wolfe multiplied this daily standard time by five days per week, and then multiplied the total by 52 weeks in the year. This gave him the totals of 1,680 minutes or 28 hours per week, and 1,456 hours per year.

By an actual time study, he found that the operating time of 256 major operations totaled 25,755 minutes. Using 100.6 minutes per operation as the average or normal time for room usage for a major case, Wolfe worked out the averages per operative case for the other types of operating rooms such as: 97 minutes for the gynecology and obstetrical room, 51 minutes for the cystoscopy

room, 45 minutes for minor surgery, 45 minutes for the cast and closed reduction room, and 59 minutes for the local and general T & A rooms combined.

Basing his percentages on average minutes per operation, Wolfe reports that of the 5,753 operations performed in the operating-room department during the year 1958, the year under study, 2,762 operations were performed in five major rooms, averaging 662 operations per room, per year, which represents an average of 2.1 operations per day, per room, or 63.6 percent room usage.

In the gynecology and obstetrical room, 730 operations were performed, representing an average of 2.8 operations per day, per room, or 81.7 percent usage.

In minor surgery, 667 operations were performed, representing an average of 2.6 percent operations per day, per room, or 34.4 percent usage.

In local and general T & A rooms combined, 558 operations were performed, representing an average of 2.1 operations per day, or a combined percentage of 37.7 percent room usage.

In the cast and closed reduction room, 230 operations were performed. But this room could not be assessed as were the others, because it is especially equipped for this kind of surgical procedure.

The actual operation time per room and the percentage of room usage averaged:

Rooms:	Hours of Actual Use and Available Time		% of Room Usage
Major (5)	926 hrs. of actual use / 1,456 hours available	=	63.6%
Gyn-ob room	1,180 hrs. actual use / 1,456 hrs. available	=	81.0%
Cystoscopy	685 hrs. actual use / 1,456 hrs. available	=	47 %
Minor	500 hrs. actual use / 1,456 hrs. available	=	34.4%
Cast and closed reductions	172.5 hrs. actual use / 1,456 hrs. available	=	11.8%
General and local T & A (combined)	549 hrs. actual use / 1,456 hrs. available	=	37.7%

The total hours of operating-room usage were 7,716. However, this total cannot be used for any average, according to Wolfe, because of the different types of operations. But, he suggests, the total hours can be used to gauge the efficiency of the personnel in the operating-room department. The total of 7,716 hours, plus the 30 percent allowance for delays, equals 10,031 hours. When this number is multiplied by the number of each type of O.R. personnel, it can give the hours in excess, or the personnel needed for the given number of operations.

Based on the percentages of room usage, Wolfe predicts it could be possible to schedule and complete the following:

Rooms	Actual Operations, 1958	Based on 336 Min. Standard Number
A,B,C,E,&M (Major)	2,762 at 63.6% available time	3,767 operations
D (Gyn-ob)	730 at 81.0 % available time	868 "
J & K (Cystoscopy)	806 at 47% available time	1,243 "
G (Minor)	667 at 34.4% available time	1,100 "
H & I (Local and general T & A)	558 at 37.7% available time	770 "
F (Cast and closed reductions)	230 at 11.8% available time	432 "
Total operations in 1958		5,753
Standard number of operations based on 336 minutes per day, per room		8,180

Wolfe concludes that this standard number of operations could be reasonably expected; however, he points out, the lack of surgical beds precludes this possibility. On the basis of 156 surgical beds a total of 56,940 in-days of care would be available for surgical patients. From the number of operations in 1958, he states the breakdown of in-days of patient care per operation shows a total of 44,-208 patient days used – leaving a surplus of 2,732 bed days available, or, converted to operations, another 1,273 major operations.

Of course, Wolfe points out, this number depends upon the days when rooms are available, and the locations of the rooms. He projects the figure 6,953 as the maximum number of operations possible under the best conditions, using every available hour of available surgical beds. And to accomplish this feat would require, according to Wolfe, the coordinating services of the most skilled administrative supervisor.

It is at this particular point that the reader finds the greatest of many inconsistencies and ambiguities which interfere with comprehension of the Wolfe report. Wolfe allows that 8,180 operations per year would be impossible because of lack of surgical bed facilities. He projects the maximum figure as 6,953 operations – 1,200 over the number of operations performed in 1958. Yet, in his summary and conclusions, he avows that an additional 2,000 operations can be done if his recommendations are carried out.

This final projected figure is presumably based on the same percentage of room usage as is the 1,200 figure. It would appear that the more ambitious projection does not take the surgical bed capacity or location into consideration.

STANDARD COSTS

Wolfe contends that by maintaining the daily charting of all operations, an operating-room department can keep check on costs and, periodically, compare these with standard costs.

Since one of the main objectives of his O.R. study was to determine what cost controls were necessary and how they should be set up, the procedure or system he recommends for these cost controls is one of the highlights of his report.

The procedure he followed is basically a standard cost system modified to accommodate the activities and policies of the Jewish Hospital and the operating-room department.

A standard cost system, writes Wolfe, must be based on what the average operation will take in on an average day under average conditions. Before arriving at his standard cost system, Wolfe had first to establish the normal number of minutes per day that an operating room should be in use. Using 100 percent of an eight-hour day or 480 minutes as his base, he allowed 30 percent, or 144 minutes, for inherent delays. The remaining 70 percent, or 336 minutes, he considered the total available time.

His next step was to do a breakdown of the total operating costs for 1958. To illustrate the methods of arriving at the different costs and percentages which are the basis for the eventual charges, Wolfe gives this example using one operating room.

Example: Total number of operations performed in 1958 were	5,753
Costs: Total direct cost amounted to	$193,854.17
Costs: Total indirect cost amounted to	$136,517.00
Income: Total income amounted to	$204,093.75

To illustrate his method of arriving at his later conclusions he uses Room "D" (gynecology and obstetrics) as a specific example:

Total operations performed	730
Hours for the 130 operations totaled	1,180
Hours for all operations in 1958 totaled	7,716

Therefore, writes Wolfe, the 1,180 hours in Room "D" represents 15.3 percent of the total operating hours.

In order to allocate the proper costs for the operations he divides the different costs by 15.3 percent, i.e.:

Total direct expense $\frac{\$193,854.17}{15.3\%} = \$29,659.68$

Total direct expense $\frac{\$29,659.68}{730 \text{ operations}} = \$40.62$ per operation

As a result of this kind of breakdown for each of the operating rooms, Wolfe has discovered that the hospital has not been charging on an equitable basis.

To allocate costs based on actual time allotted to each type of operation, Wolfe did the following breakdown:

Total Number of All Operations—7,716 hours

Rooms	Operations	Hours	Percentages
A,B,C,E,M	Major	4,630 or	60
D	Gyn-ob	1,180 or	15.3
J & K	Cystoscopy	685 or	8.8
G	Minor	500 or	6.5
F	Casts & closed reductions	172.5 or	2.25
H & I	General and local T & A	549 or	7.2

Through his study Wolfe found that the major operations, which represented 40 percent of the operations, absorbed 61.2 percent of the man hours involved. (However, he does not report how he arrived at this latter percentage.)

The breakdown based on studies of operating-room usage showed:

Rooms	Operations	Percentage of Operations	Cases per Year
A,B,C,E,M	Major	48	2,762
D	Gyn-ob	12.7	730
J & K	Cystoscopy	14	806
G	Minor	11.6	667
H & I	General and local T & A	9.7	558
F	Casts and closed reductions	4	230

Based on a 40-hour week, there is 2,080 minutes available usage per room, per year, but due to inherent delays which represent 30 percent of this time, the actual operation time available per year is 1,456 hours.

To follow through on Wolfe's example using the gynecology-obstetrics room, his cost analysis is as follows:

Room "D" (Gyn & Ob.) 12.7 percent of the year's total operations.

$\frac{5,753}{12.7\%} = 730$ operations at average of 97 minutes per operation

$\frac{1180 \text{ actual hours}}{1456 \text{ standard hours}}$, or an efficiency use of 81%

According to Wolfe, the cost of operating room "D" with 81 percent usage is:

Total Direct Costs

$$\frac{\$193,854.17}{15.3\% \text{ of hrs.}} = \$29,659.68$$

= $40.62 Direct Cost per Operation

Total Indirect Costs

$$\frac{\$136,517.00}{15.3\%} = \frac{\$20,887.10}{730 \text{ opr.}}$$

= $28.61 Indirect Cost per Operation

$69.23 Total Cost per Operation

Total Income

$$\frac{\$204,093.09}{15.3\% \text{ of hrs.}} = \frac{\$19,388.00}{730 \text{ opr.}}$$

= $31.22 Income per Operation

= $38.01 Deficit per Operation

Wolfe arrives at this figure as the standard cost —$56.07—based on 100 percent usage. As a result of his study, Wolfe recommends a new system of operating charges. The current ones, he states, were evidently predicated on an eight-hour usage. However, realistically, it is a physical impossibility to use an operating room constantly, without delays. He suggests, therefore, a new schedule of charges based on standard usage.

SUPPLIES AND EXPENSES

The purchasing power of operating-room personnel is well known to surgical supply manufacturers and salesmen, but not so well known is their negligence in record-keeping as revealed to Wolfe and his management-engineering team. Wolfe claims that he discovered that the person who ordered the supplies did not know the costs.

However, he adds, O.R. personnel are not trained for this kind of record-keeping; they do not have the time to maintain proper records and keep costs down. This, he believes, is an administrative responsibility—a responsibility that could be carried out by adopting his proposal for the administrative coordinator for the operating-room department described earlier in this review.

The total figure quoted by Wolfe for supplies and expenses in 1958 was $81,232. And of the money spent for supplies, over 29 percent of it was expended on suture thread. To Wolfe, this represents 14 sutures per operation. Obviously, he could not refrain from raising the question: Need all these sutures be used? During his study period, he states he frequently observed as many as four sutures opened during an operation and discarded without being used. He points out that savings can be effected in the operating-room department only if every member of the team cooperates.

As a partial solution and to assist the employee in charge of purchasing supplies, Wolfe suggests that requisitions for supplies be completed in

duplicate. He also suggests that when the merchandise arrives the price of the item should be pasted on the card and the duplicate given to the department head after he signs for acceptance of the item.

Wolfe also spells out a detailed system for recording purchases made by the operating-room department, which might interest readers of his report.

Throughout Wolfe's study, two prevailing themes recur: (1) the need to employ an administrative coordinator of the operating-room department who will report to the administration of the hospital, and coordinate the needs of the division of surgery and department of nursing; (2) the need to revise the operating-room scheduling system.

He maintains that the employment of an administrative coordinator who would have the authority to supervise operating-room scheduling and room usage, effect a systematic control of purchases, and utilize O.R. personnel as needed, would provide sounder management in the operating-room department and, in time, would reduce the monetary deficit of this department.

Wolfe's statistical findings would seem to substantiate his recommendations. However, there is many a slip between what should be done and what can be done. No David is he, but it would appear that Wolfe is most certainly setting up himself or someone else, armed with no more lethal weapon than a time-study form and a stop watch, to meet Goliath. Nevertheless, his report is well worth reading if only as a tribute to a courageous man.

Principles of Effective Recovery-Room Care*

By Melvin I. Gibbel, M.D.**

This detailed description of a routine for effective care of the postoperative patient originally appeared as part of Dr. Gibbel's article, "Pitfalls in Preoperative and Postoperative Care," in the February 1958 issue of the Surgical Clinics of North America. *The accompanying photographs were taken by* Hospital Topics *to illustrate some of the key points in the article.*

One of the most critical periods in the patient's postoperative course is after the wound has been closed and the dressings are in place. Frequently the primary concern of the operating-room personnel then becomes the evacuation of the operating room as rapidly as possible in order to proceed with a heavy operating schedule. The stage is set for serious postoperative complications if certain pitfalls are not avoided.

*Reprinted with permission from *The Surgical Clinics of North America*, Vol. 38, No. 1, February 1958.

**Clinical assistant professor of surgery, University of Illinois College of Medicine; chief of surgery, West Side Veterans Administration Hospital, Chicago.

———Essentials of Transportation Equipment

Often little consideration is given to the type of equipment available for the movement of the patient to the recovery room.

The usual hospital cart as illustrated in figure 1 is adequate for the transportation of the patient following minor surgical procedures under local anesthesia. It holds grave dangers for the patient who is under general anesthesia, however, and respiratory obstruction and death may not be far off.

The recovery-type bed which can serve the dual purpose of transportation and of a hospital bed while the patient remains in the recovery room is optimal (figure 2). Special features which these beds should include[1] are: (1) a width narrower than the regular hospital bed to permit more maneuverability and more space in the recovery room; (2) casters large enough to permit ease of movement; (3) adequate adjustments available to permit ease of positioning the patient; (4) built-in side rails to protect the patient in transit and also to prevent his falling out of bed during the immediate recovery period from the anesthetic; (5)

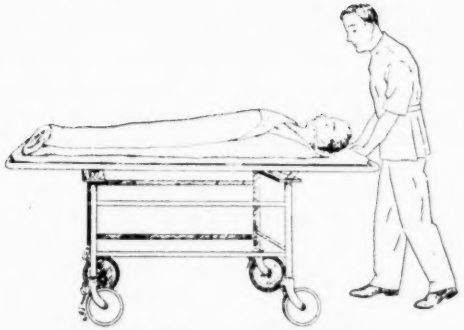


Fig. 1: Inadequate transportation method using regular hospital cart with attendant.

a removable headboard to facilitate emergency intubation or bronchoscopy.

The patient may be brought to the operating room on a hospital cart and then at the completion of the operation placed in the recovery bed where he remains until he is returned to the ward.

If an untoward emergency arises in the recovery room, treatment is facilitated in this type of bed and he can be quickly returned to the surgical suite where, if necessary, surgical maneuvers can be performed in the bed.

Determination of Transportability

Even though the ultimate responsibility for the decision to move the patient to the recovery room rests with the operating surgeon, he must usually rely on the evaluation of the patient's present status by the anesthesiologist.

The patient should not be moved from the operating table if uncorrected hypovolemia with shock exists; if there is significant respiratory depression;

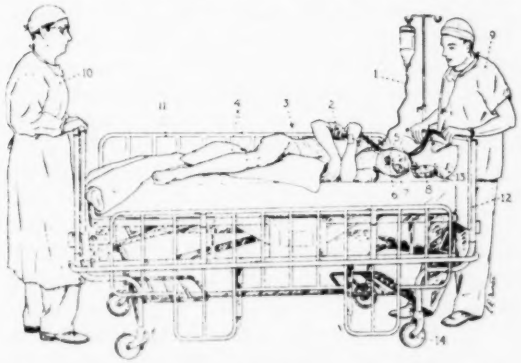


Fig. 2: Adequate transportation of patient — 1. intravenous fluids in arm; 2. blood pressure cuff in place; 3. lateral recumbent position; 4. flexion of legs with pillow between; 5. oral airway; 6. intratracheal tube; 7. nasogastric tube; 8. emesis basin; 9. anesthesiologist; 10. surgeon; 11. side rails; 12. removable headboard; 13. pillow above head; 14. large casters.

if cardiac decompensation with pulmonary edema exists or if other serious conditions which may be remedied in short order are not corrected.

The *sine qua non* of this period is continuity of observation and treatment. This can be accomplished only when the surgeon and anesthesiologist remain in constant attendance.

After transportability has been established, the patient is moved slowly and gently from the operating table to the recovery room bed.

The position of the patient is of great importance during his transportation. Nausea and vomiting are frequent in the immediate post-anesthetic period. If the patient is semiconscious with depressed reflexes and is placed in the supine position, vomiting will frequently be followed by a severe aspiration pneumonia, secondary to regurgitation of acid gastric juice.

The blood pressure cuff should be left in place and the pressure again checked after the movement to the recovery bed. Parenteral fluids are continued during the transportation.

If general anesthesia was administered and an intratracheal tube is in place, this is not removed unless the patient has fully reacted. The rubber oral airway is also left in place.

The nasogastric tube should have had suction applied during the surgical procedure and should not be clamped during the patient's movement to the recovery room.

Aspiration of gastric contents by the lungs during anesthesia is more frequent than is generally believed. Culver[2] studied 300 unselected surgical patients by placing Evans blue dye in the stomach before induction of anesthesia, and when the operation was completed the larynx, trachea and main bronchi were inspected and all secretions aspirated. Dye appeared in the pharynx in 26 percent and below the vocal cords in 16 percent of the patients. Silent aspiration without observable emesis occurred in eight percent. Aspiration was four times higher in patients without gastric tubes in place.

The patient should be moved in the lateral recumbent position (figure 2) with a large pillow between the flexed knees.

The side rails should always be up during the movement of the patient. If they are not available, then straps should be used. Such precautions will prevent serious injury to an arm or leg.

The movement should be accomplished under the direction of the surgeon and the anesthesiologist. *Under no circumstances should the movement of the semiconscious patient be entrusted to a nurse or an operating-room attendant.*

———Reception of Patient in Recovery Room

After the patient has been safely transported to the recovery room a second critical period in his

recovery begins. The blood pressure is again checked and if the patient has reacted sufficiently and the intratracheal tube is still in place, the trachea is aspirated and extubation is accomplished by the anesthesiologist. The oral rubber airway is left in place until he is fully conscious.

The vital signs are checked by the surgeon. Any drainage tubes are checked and correctly attached to the suction or drainage bottles. The intravenous fluids are checked to be sure they are still running.

Orientation of Nurses

The nurse is oriented as to the patient's present condition and is instructed as to any special attention that is necessary as to airway, intravenous fluids, drainage tubes or position of the patient. The nurse should be informed of any possible complications that are anticipated.

Acute respiratory obstruction and postoperative hemorrhage are the two most common and most serious complications that may occur in the recovery room during the first few hours after operation. These are of such a nature that the diagnosis must be made quickly and adequate therapeutic measures taken.

The routine and frequent checking and recording of the patient's pulse, blood pressure and respiratory rate during this period should alert the nurse as to developing complications.

Careful observation of the respiratory system includes not only respiratory rate but also the depth of respirations and the possible development of cyanosis, laryngeal stridor or intercostal muscle retraction.

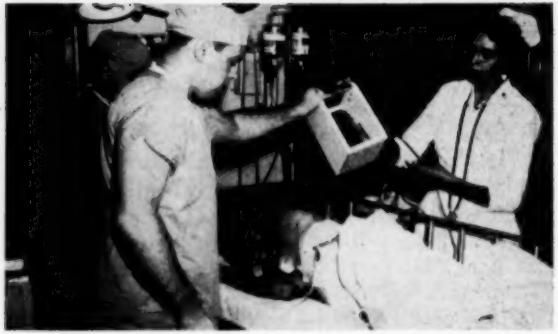
Continued observation of the circulatory system must include, in addition to blood pressure and pulse, the color, temperature and hydration of the skin and mucous membranes; the pulse volume and rhythm; any evidence of blood loss on the dressing or through drainage tubes, and any unusual restlessness of the patient. It should be emphasized that restlessness frequently is due to hypoxia rather than pain and can be relieved with oxygen therapy and will only be aggravated by the further use of narcotics.

The nurses must be instructed that any marked change in the status of the cardiorespiratory function should be immediately reported to the surgeon.

A frequent pitfall is inadequate orientation of the nurse so that adequate observation of the patient is obtained but serious developments are overlooked or, even worse, are observed but are not reported to the surgeon.

Orders

Oral instructions are first given but these must also be supplemented by complete detailed written orders. The latter are too often neglected, which leads to unnecessary confusion and often inadequate therapy.



Above (left): Patient arrives at recovery room in West Side VA Hospital, attended by Harold Luzzie, M.D. (l.), anesthesiologist, and Daniel McCarthy, M.D., resident surgeon. Recovery room normally accommodates six patients, but may be expanded to hold eight or nine. The room is available 24 hours a day.
Above (right): Inside recovery room, Samantha Johnson, R.N., aids doctors in making patient comfortable and setting up necessary equipment, fluids and drainage bottles. She is handing wooden frame for water-seal bottle to Dr. McCarthy. The bottle is for drainage of excess fluids and blood from thoracic cavity. At top of frame is a light bulb, added at the suggestion of an aide at the hospital. It helps the nurse to see bottle's contents and observe tube's functioning. Left: As nurse assists doctors, she also listens attentively while they give her oral orders. Opposite page, above (left): At nurse's desk, doctor reinforces oral orders by leaving them in writing. Day's schedule of operations is on clip board

attached to bulletin board. A compact FM radio unit provides soft music for the room. The music seems definitely beneficial to patients, and the nurses also appreciate it, Miss Johnson says. Above (right): Miss Johnson makes routine blood-pressure check. Patients who have had general anesthesia are checked every 15 minutes until they respond — then every half hour. Those who have had spinal anesthesia are checked every 15 minutes for the first hour, then every half hour for the next two hours, then every hour until they leave the recovery room. Right: Postoperative support of the wound with a scultetus binder often aids coughing, Dr. Gibbel believes. He emphasizes that binder should be snug but not tight, so that chest and abdominal expansion is not impaired. Here Miss Johnson shows that she can insert her hand between binder and patient's body. Patient is encouraged to cough every 15 to 30 minutes, depending on amount of tracheal secretions present. He is instructed to take 10 to 12 deep breaths every 30 minutes.

Specific orders in relation to individual diseases or operations are considered in other articles. There are certain generalizations, however, which can be made and which should serve as a guide.

Even though we are all aware of the importance of the type and amount of fluids administered, the rate is often designated for a 24-hour period. This often leads to considerable variation in hourly rate. Often the fluids may run slowly for 16 to 20 hours and then suddenly the nurse becomes aware of the amount still to be administered and the remaining two-thirds will be given in one or two hours. This should be avoided by ordering the 24-hour parenteral fluid requirement in eight-hour increments so that each nursing shift will have its own goal and responsibility.

Intake and output records should be routine on postoperative patients, and where they are not, then specific orders must be written.

Orders for the control of pain are always necessary. Too often the doctor's sympathy for the patient or his desire to keep the recovery room quiet leads to overmedication with its detrimental effect on the patient. The use of opiates and narcotics should be held to a minimum. When they are ordered, the orders should state specifically for what symptom they are intended and then only as necessary. Too frequently the opiates are used as a sedative or soporific when small doses of a barbiturate would have been adequate. This leads to respiratory depression and to increased postoperative ileus. When possible, pain should be controlled with regional blocks and/or salicylates.

The Stir-up Regimen

By far the most frequent complications that arise in the immediate postoperative period are related to the respiratory system.

The continued study of pulmonary complications, their etiology, prevention and treatment, during the last 50 years has led to certain established facts and principles of preoperative and postoperative management, which are listed below.

1. Upper abdominal operations are more often complicated by pulmonary complications than operations in the lower abdomen.

2. Pre-existing pulmonary disease or infection predisposes to complications. As stated previously, this may often become apparent only from the history. Where elective surgical procedures are contemplated, they should be delayed two to three weeks after an acute upper respiratory infection. Where chronic pulmonary disease exists, surgery must be delayed until the patient has been treated and reached optimum pulmonary function.

3. The role of heavy cigarette smoking in pulmonary disease is becoming more apparent. The chronic pharyngotracheobronchitis which develops

makes surgery more hazardous. These people should reduce their consumption to less than one-half pack of cigarettes per day for several weeks before operation.

4. Severe dental caries should be treated before elective surgery.

5. Obesity should be controlled by diet and weight reduction before elective surgery. Pulmonary complications are increased in the overweight patient.

6. Proper choice as to type and length of incision is important. Less pain is experienced with transverse incisions. The incision should be long enough to give adequate exposure with a minimum of strong retraction.

7. Gentleness and care in handling of tissue at operation decrease postoperative pain and aid pulmonary ventilation.

8. Heavy preoperative sedation often reduces the cough reflex and thickens the secretions so that atelectasis is present even before the operation has begun.

9. The preoperative use of a nasogastric tube to remove retained stomach secretions and its postoperative use to prevent and reduce abdominal distention are important.

10. Postoperative support of the wound with a scultetus binder often aids coughing. The binder should only be snug and not tight, so that chest and abdominal expansion is not impaired. Teaching the patient to support his wound while coughing also reduces pain.

11. Preoperative instruction of the patient, either by a trained physiotherapist or the surgeon, in deep breathing, diaphragmatic breathing and coughing makes the immediate postoperative stir-up regimen more effective.

It becomes apparent from the above principles that the primary mechanism for development of pulmonary complications is the retention of bronchial secretions. While often the causes are multiple, the basic one is retained bronchial secretions with obstruction.

The prevention of the accumulation of these secretions is one of the major problems in the postoperative period. The method used to accomplish this has been called the *stir-up regimen.*[1] This should become an established routine in the recovery room, but it must also be continued after the patient has been returned to his room. The essentials of this regimen are:

1. *Cough.* The patient must be encouraged and, if necessary, coerced to cough every 15 to 30 minutes, depending on the amount of tracheal secretions present. Support of the operative wound by the patient or by a binder will make the cough more effective.

2. *Deep Breathing Exercises.* The patient should

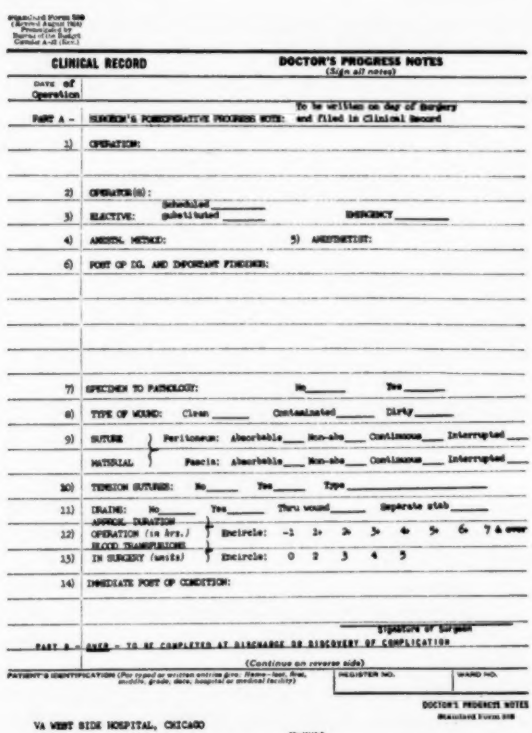
take 10 to 12 deep breaths every 30 minutes. These should be checked occasionally by the nurse or physician to be sure they are being adequately performed.

3. *Change in Position.* The patient must be instructed to move from back to side and from side to side. During the first few days he will need assistance, but this should be kept to a minimum.

4. *Mobilization.* The patient should be instructed in the early movement of the feet and legs while lying in bed. He must be encouraged in this and his performance checked. Early ambulation is encouraged. Sitting on a chair or the side of the bed may cause obstruction to venous flow in the legs and predispose to phlebothrombosis.

5. *Narcotics and Sedatives.* Their use must be kept to a minimum. Their specific action in depressing the cough reflex and also the ciliary action within the bronchi only hinders the expectoration of secretions.

6. *Carbon Dioxide.* Where the patient refuses or is unable to breathe deeply and cough, carbon dioxide will be of value. This should be given with an air mixture and not as an oxygen mixture. This is easily accomplished by directing the gas through a catheter to within 10 to 12 inches of the patient's face. It should be continued only until deep breathing and cough occurs. This may be repeated several times per hour.



CLINICAL RECORD — DOCTOR'S PROGRESS NOTES (Sign all notes)

DAYS of Operation

PART A – SURGEON'S POSTOPERATIVE PROGRESS NOTE: To be written on day of Surgery and filed in Clinical Record

1) OPERATION:

2) OPERATION(S):

3) ELECTIVE: Scheduled ____ Substituted ____ EMERGENCY ____

4) ANESTH. METHOD: 5) ANESTHETIST:

6) POST OP DG. AND IMPORTANT FINDINGS:

7) SPECIMEN TO PATHOLOGY: No ____ Yes ____

8) TYPE OF WOUND: Clean ____ Contaminated ____ Dirty ____

9) SUTURE — Peritoneum: Absorbable ___ Non-abs ___ Continuous ___ Interrupted ___
MATERIAL — Fascia: Absorbable ___ Non-abs ___ Continuous ___ Interrupted ___

10) TENSION SUTURES: No ____ Yes ____ Type ____

11) DRAINS: No ____ Yes ____ Thru wound ____ Separate stab ____

12) OPERATION (in hrs.) / BLOOD TRANSFUSIONS — Encircle: -1 1+ 2+ 3+ 4+ 5+ 6+ 7 & over

13) IN SURGERY (units) — Encircle: 0 1 2 3 4 5

14) IMMEDIATE POST OP CONDITION:

Signature of Surgeon

PART B – NOTE – TO BE COMPLETED AT DISCHARGE OR DISCOVERY OF COMPLICATION

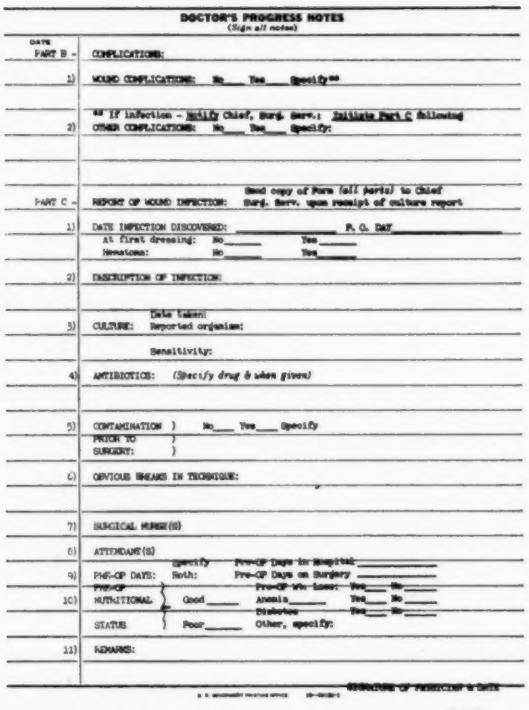
(Continue on reverse side)

PATIENT'S IDENTIFICATION (Per typed or written entries give: Name—last, first, middle; grade; date; hospital or medical facility) REGISTER NO. WARD NO.

DOCTOR'S PROGRESS NOTES

VA WEST SIDE HOSPITAL, CHICAGO

Fig. 3: Overprint form for initial postoperative note.



DOCTOR'S PROGRESS NOTES
(Sign all notes)

DATE

PART B -
1) COMPLICATIONS:
WOUND COMPLICATIONS: No___ Yes___ Specify**
** If infection - notify Chief, Surg. Serv.: Initiate Part C following
2) OTHER COMPLICATIONS: No___ Yes___ Specify:

PART C -
REPORT OF WOUND INFECTION: (Send copy of Form (all parts) to Chief Surg. Serv. upon receipt of culture report
1) DATE INFECTION DISCOVERED: _____ P. O. Day_____
At first dressing: No_____ Yes_____
Sequelae: No_____ Yes_____
2) DESCRIPTION OF INFECTION:
Date taken:
3) CULTURE: Reported organism:
Sensitivity:
4) ANTIBIOTICS: (Specify drug & when given)
5) CONTAMINATION) No___ Yes___ Specify
PRIOR TO)
SURGERY:)
6) OBVIOUS BREAKS IN TECHNIQUE:
7) SURGICAL NURSE(S)
8) ATTENDANT(S)
9) PRE-OP DAYS: Specify Both: Pre-OP Days in Hospital:_____ Pre-OP Days on Surgery _____
10) NUTRITIONAL STATUS: Pre-OP Wt. Loss: Yes___ No___ Good_____ Poor_____ Anemia_____ Yes___ No___ Diabetes Yes___ No___ Other, specify:
11) REMARKS:
SIGNATURE OF PHYSICIAN & DATE

N-1104

Fig. 4: Overprint form for postoperative complications.

Progress Notes

Adequate progress notes are essential for continuity of patient care. Frequently emergencies arise in the recovery room at a time when the responsible surgeon is not available. The physician who gives treatment must have a ready source of information as to the patient's past treatment.

Because of the difficulty in getting surgeons to write adequate postoperative notes, we have prepared an overprint to be stamped on our standard form called "Doctor's Progress Notes" (figure 3). This requires little writing but assures that adequate information will be contained in the initial postoperative note. The back of this form (figure 4) is used for the recording of postoperative complications and especially wound infections. These forms have aided in patient care and also contribute to quicker and more accurate accumulation of statistical data.

Summary

Some essentials of preoperative and postoperative care which are often overlooked and may lead to serious complications have been discussed. To be forewarned is to be forearmed is the theme of good preoperative evaluation and preparation. Only then are the pitfalls avoided or minimized.

REFERENCES

1. Sadove, M. S., and Cross, J. H.: *The Recovery Room—Immediate Postoperative Management*. W. B. Saunders Co., Philadelphia, 1956.
2. Culver, J. A., Makel, H. P., and Beecher, H. F.: "Frequency of Aspiration of Gastric Contents by Lungs During Anesthesia and Surgery," *Ann. Surg.* 133:289 (March) 1951.

Prevention of Cancer Dissemination During Surgery

Surgery for cancer is high on the list of operations at the 650-bed University of Illinois Research and Educational Hospital in Chicago. Usually it is performed daily. The morning TOPICS' reporter visited, three of the 11 patients operated upon were cancer patients.

The exhibit on the prevention of cancer dissemination, shown on page 50, is "a compilation of many things we have known for a long time," according to William J. Grove, M.D., associate professor of surgery at the University of Illinois College of Medicine. The exhibit was planned by Warren H. Cole, M.D., chief of surgery and immediate past president of the American Cancer Society; Dr. Grove; and Stuart S. Roberts, M.D., LeRoy Long, M.D., and Olga M. Jonasson, M.D., all residents in surgery.

"Our working philosophy," said Dr. Grove, "stems from a statement made by Dr. William Mayo in 1913. He said, 'Cancer should be treated like a focus of infection.' It is our hope that the exhibit will help doctors and nurses to further understand their patients. We want them to think of cancer in terms of bacteria within the patient, and to handle it as though it were.

"In our own procedures, the implications of this statement are emphasized over and over again; every doctor and every nurse is fully aware of the responsibilities they entail."

At the present time, more than one-half the patients having curative resections for cancer return with metastases and die. Undoubtedly, according to the information contained in the exhibit, microscopic metastases were already present in some of

these patients at the time of treatment. In many cases, according to the surgeons' collective conclusions, certain phases of the initial management contribute to the dissemination of cancer.

Physical examination may disseminate cancer:

Manipulation during pelvic or rectal examination and palpation of solid tumors has been associated with showers of cancer cells in the blood stream during rectal examination, palpation of an abdominal mass, pelvic examination, and rupture of a malignant ovarian cyst during a pelvic examination.

Diagnostic procedures may disseminate cancer:

Massage to obtain secretions or the opening of vascular channels during biopsy have been associated with showers of cancer cells in the blood stream during curettage of malignant bone tumor, prostatic massage, uterine curettage, and curettage of uterine adenoacanthoma.

Operative measures may disseminate cancer:

Manipulation during skin preparation and mobilization of a tumor have been associated with showers of cancer cells in the blood stream. Contamination of operative areas by cancer cells has resulted in implantation recurrences. Examples are skin preparation over a breast tumor, operative manipulation of bowel or kidney, and local seeding of wound during radical mastectomy.

The mechanisms of dissemination are threefold: invasion, intravasation, and implantation.

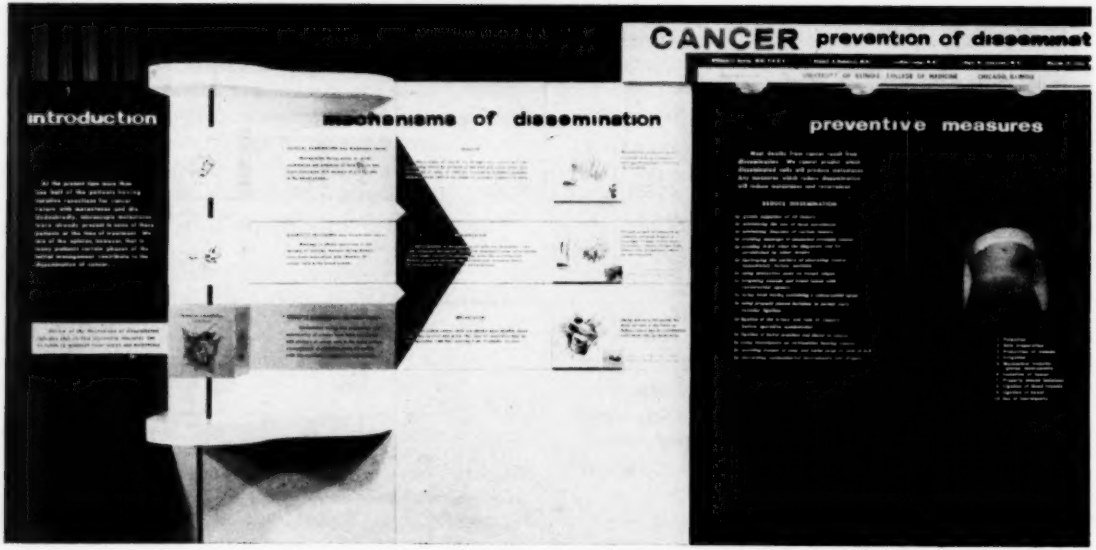
Invasion: Many types of cancer are brought into contact with the circulating blood in invasion of the wall and penetration into the lumen of veins. In addition, invasion of lymphatic channels places cancer cells in the lymph for possible transport to veins.

Manipulation incident to physical examination or operation may dislodge an intravascular tumor into the circulation. An example is a tumor embolus recovered from the inferior vena cava during prostatic massage.

Intravasation: This process is the passage of cells into lacerated veins from adjacent disrupted normal or neoplastic tissue. Intravasation occurs under certain circumstances when the extravascular (tissue) pressure exceeds the intravascular pressure.

Procedures such as transurethral resection, incisional biopsy, or curettage of deep-seated tumors, in contrast to biopsy of superficial tumors, may disseminate cancer by intravasation. An example is a bone marrow-tumor embolus found within the pulmonary artery after bone curettage.

Implantation: When viable cancer cells are seeded upon suitable tissue, some may survive and grow. This type of recurrence must be distinguished from that resulting from incomplete excision.



During operation, the wound, the body cavities, or the lumen of hollow viscera may be contaminated with cancer cells by implantation. An example is a suture at a colon anastomosis surrounded by recurrent tumor.

Most deaths from cancer result from dissemination, but it cannot be predicted which disseminated cells will produce metastases. Any measures which reduce dissemination will reduce metastases and recurrences.

Here are the measures used and recommended by this surgical team:

1. Gentle palpation of all tumors during physical examination and operative manipulation.

2. Minimizing use of local anesthetic, thereby minimizing the possibility of intravasation and/or implantation.

3. Minimizing biopsies of certain tumors.

4. Avoiding massage of suspected prostatic cancer.

5. Avoiding D. & C. when the diagnosis can be established by other means.

6. Destroying the surface of ulcerating cancer immediately before excision.

7. Using protective pads on wound edges.

8. Irrigating wounds and bowel lumen with cancerocidal agents after resection.

9. Using wash basins containing a cancerocidal agent.

10. Using incisions properly placed to permit early vascular ligation.

11. Ligation of the artery and vein of a tumor before operative manipulation.

12. Ligation of bowel proximal and distal to cancer.

13. Using tourniquets on extremities bearing cancer.

14. Using antiseptic solution for skin preparation rather than the more vigorous soap and water preparation.

15. Changing instruments, gowns, gloves, and other items before moving from a cancer-contaminated area to a clean area.

Though all the precautions listed above are important to the operating-room nurse, and she must be fully conversant with each, numbers 9, 14, and 15 apply to her most specifically, according to Fannie Nofziger, operating-room supervisor.

"Every procedure," said Miss Nofziger, "is prefaced by the unalterable law that we do not scrub the area with soap and water, but use an antiseptic solution. If a breast biopsy is positive, we have a completely different setup for the mastectomy. The patient is redraped, and sterile gowns, gloves and a complete new set of instruments are used.

"Following any radical, all instruments are removed, the area is completely redraped, and we irrigate the wound with cancerocidal agents before the wound is closed."

Instructions to medical staff members and O.R. nurses for wound irrigation following cancer surgery are specific and in written form:

Irrigation of wounds with buffered 0.5% sodium hypochloride solution will be performed at the conclusion of the following surgical procedures:

1. *All* radical mastectomies. This includes both treated and control cases receiving nitrogen mustard. *All palliative* mastectomies and those *over age 70,* or *recurrent* cases also will be irrigated.

2. All other definitive cancer operations performed on the general surgical services will be

designated as irrigation or control cases according to the posted selection chart. This will include all head and neck, axillary and groin dissections, and procedures for soft-tissue malignancies. It does *not* include gastrointestinal and intrathoracic malignancies. Controls will receive *no* irrigations.

Preparation of solution for wound irrigation (this buffered 0.5% sodium hypochloride solution must be used within 15 minutes of its preparation):

1. To a sterile 1,000-ml. graduated container, (a) add 200 ml. of sterile distilled water, the temperature of which should not exceed 40° C. (b) Then add the contents of bottle A (liquid) and bottle B (powder), and (c) add more distilled water to make a final volume of 1,000 ml.

2. Gently agitate the solution so the powder will dissolve (stir gently). It is now ready for use, and must be used within 15 minutes. (Note: Bottle A contains 106.6 ml. of a 5.25% sodium hypochlorite solution. Bottle B contains 10.7 g. of sodium bicarbonate. Bottles A and B are taped together. The contents of both A and B bottles must be used to prepare the solution.)

3. Using the Addressograph plate, stamp the attached card and give the date and surgical procedure performed.

Method of wound irrigation:

1. At the conclusion of the surgical procedure just prior to suturing of the wound, remove all skin towels, laparotomy pads, and sponges from and about the wound.

2. Wash all blood and debris from the skin surrounding the wound area and wipe the skin surface dry.

3. All members of the surgical team and the scrub nurse change gloves. All previous instruments and splash basins must be discarded.

4. The scrub nurse now uses the wound closure instrument pack and prepares the wound-irrigating solution.

5. With blunt retractors the wound is opened widely and irrigated with approximately 750 ml. of the solution. Use an Asepto syringe and irrigate all parts of the wound including the skin edges, and the skin surface around the wound. With the first two syringefuls, attempt to quickly place the solution in contact with all parts of the wound. Continue to irrigate all portions of the wound for an absolute minimum period of four minutes. The elevated skin flaps serve to form a collecting pocket. When overflow occurs, aspirate with clean suction tip. Wipe the skin surface around the wound with sponge moistened with the solution. Then close the wound in the usual manner.

Disposable Plastic 'Isolator' for Surgery

Surgery in a germfree environment—with the operative area shut off under a plastic "isolator"—is the goal of a team of surgeons at the Walter Reed Army Medical Center, Washington, D. C.

The Walter Reed experiments represent an attempt to apply the technic of the germfree laboratory to the hospital operating room. The isolator was described in a paper presented at the clinical congress of the American College of Surgeons by Stanley M. Levenson, M.D., Ole J. Malm, M.D., Richard E. Horowitz, M. D., and William H. Moncrief, Jr., M.D., of Walter Reed, and P. C. Trexler, department of biology, University of Notre Dame.

The flexible, disposable isolator, which is glued aseptically to the surgically prepped operative skin area, is designed to achieve absolute exclusion of the wound from the ordinary operating-room environment, and, conversely, the exclusion of the patient and the surgical team from the wound environment. The surgeon operates through the sterile plastic chamber.

This method has been used successfully in operation on animals in an ordinary operating room. The isolator environment and the wounds have remained sterile throughout the operations. The technic is now ready for trial on patients.

The patient and the surgical team are outside

the isolator; the anesthetist has unlimited access to the patient's head and extremities. Only the wound and underlying tissues and organs come into contact with the isolator's interior sterile environment.

Helmet-jacket combinations are worn by the surgeon and his assistants (see illustrations), instead of the conventional arm-length gauntlets used in surgery on germfree animals. They have their own air supply. Visibility, ventilation, and comfort are good, and provision is made for any necessary changing of gloves.

Instruments and supplies are inside the isolator, but their supporting tables and stands are outside. Additional supplies can be moved in through a "split-seam" sterile transfer.

Rapid transfer of unanticipated supplies needed to meet an emergency, the surgeons said, can be made through an opening designed to take advantage of the slight positive pressure of the air inside the isolator.

Sterile air enters the isolator through the same type of fiberglass filter used in the germ-free laboratory. The effectiveness of the filter in holding back micro-organisms has been proved repeatedly.

The disposable isolator, containing instruments and supplies, may be sterilized with ethylene oxide or by steam under pressure, depending on the type of plastic used.

"Despite 'aseptic' technics now practiced in hospitals, 'clean' elective operations too commonly end in wound infections, creating urgent problems for patients, surgeons, and hospitals," the surgeons said, in explaining why they decided to develop the isolator.

"Many of these infections are caused by contaminations of the wound by exogenous pathogenic micro-organisms in the environment during operation. The sources of these organisms are well known; they come mainly from the respiratory tracts of the surgical team and from circulating air, and serve to make descriptions of 'operating aseptically' upon man wishful fancies, not accomplished realities."

In germfree laboratories in the United States, Sweden, and Japan, ordinary, contaminated laboratory animals are routinely operated upon under completely sterile conditions, the Walter Reed group pointed out. Sterility has been proved by repeatedly negative wound cultures and by the successful delivery by cesarean section of near-term fetuses which grow to adulthood and remain germfree throughout their lives.

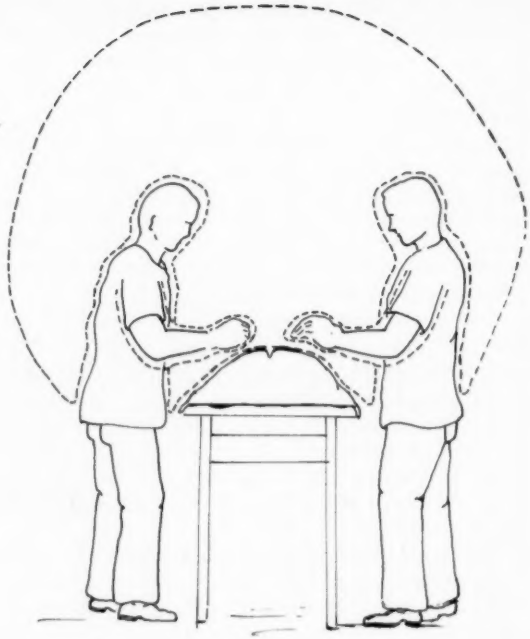
In animal surgery, the animals usually are in heavy stainless steel tanks, equipped with gauntlet-type gloves. Tanks big enough for man would be awkward and impractical; the anesthetist could

not take care of the patient adequately, and the gauntlets would permit only limited movements of the operating team.

However, there is another type of isolator which has been used successfully in the last two years for the rearing of germfree animals. The isolator used at Walter Reed is a modification of this flexible plastic isolator, which was designed by Mr. Trexler at the University of Notre Dame. Helmet-jacket combinations were substituted for the conventional arm-length gauntlets, to permit free and easy movement of the surgeon and his assistants.

There are potential uses for the isolator outside the operating room, according to Dr. Levenson. It can be used for the isolation of patients who are particularly susceptible to infections, such as patients exposed to serious whole-body irradiation, and for isolation of patients with serious infections, to prevent spread of their pathogenic micro-organisms.

"For these applications," he said, "the patients would be inside the isolators. The air pressure would be positive for the former, negative for the latter."



Drape for Transurethral Prostatectomy*

By Jack Lapides, M.D., Nancy J. Conway, R.N. and
Theresa A. Zapp, R.N.**

Several years ago it occurred to us that our setup for transurethral prostatectomy needed modernization. Our drapes at that time included the usual lithotomy sheet and two leg covers. Defects observed with these materials included (1) necessity of having another person in the operating room to tie the lithotomy sheet in place, (2) intermittent poor drainage of irrigating fluid from the drain pan because the drain opening in the lithotomy sheet had slipped upward, and (3) multiple collections from the drain pan and bucket to obtain all of the resected prostatic tissue.

In order to obviate these difficulties, a one-piece drape was devised. The drape can be applied to the patient by the surgeon without aid from other personnel. Drainage of irrigating fluid from the pan is improved because the drainage opening in the drape has been enlarged to the size of the drainage pan. The collection of prostatic tissue following operation has been simplified by incorporating a cloth mesh into the drainage opening of the drape; thus all of the resected tissue will be found on top of the mesh instead of in the drainage pan and pail.

The materials used in making the drape include pre-shunk unbleached muslin, and mesh obtained from the net laundry bag† commonly used by hospitals. The drape can be made readily in any hospital linen room.

*Reprinted with permission from the January, 1960, issue of the *Journal of Urology*, published by the Williams & Wilkins Co.
**From the section of urology, University of Michigan Medical Center and VA Hospital, Ann Arbor, Mich.

†Leno weave laundry net obtained from Fry Brothers Co., 3600 Cardiff Ave., Cincinnati, O.

Figure 1 depicts the dimensions of the drape in inches. Note that the opening for the genitals measures 5 by 7 inches and the size of the mesh for drainage is 9 by 12 inches; a double thickness of mesh is employed. The portion of the drape used to cover the lower extremity measures 47 by 56 inches.

The sheet must be folded in a particular manner in order to simplify draping the patient. Essentially each leg piece is accordion-pleated toward the center. This results in a rectangle with a length of 54 inches and a width equal to the two leg folds. The rectangle is made into a square by folding the lower portion of the drape upward and the upper part of the drape down upon the folded lower segment. The underside of the squared drape presents the opening for the external genitalia in its center.

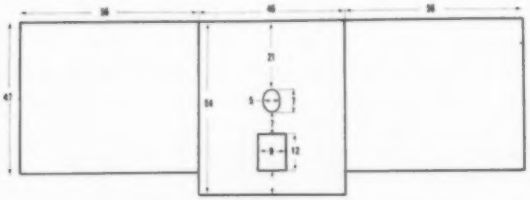


Figure 1

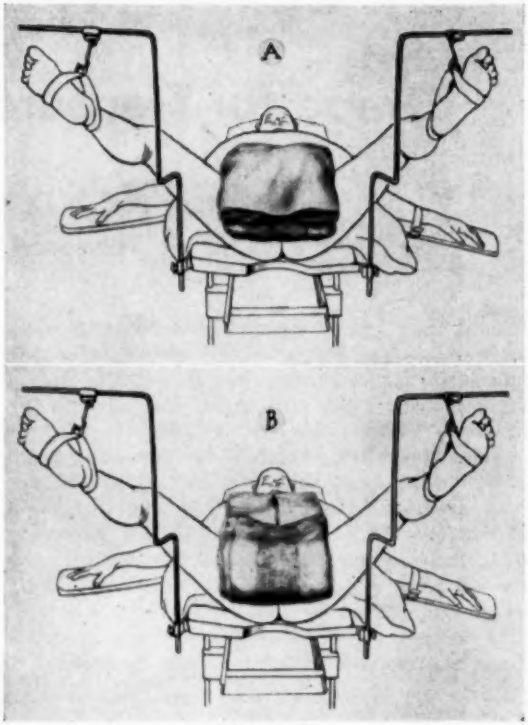


Figure 2

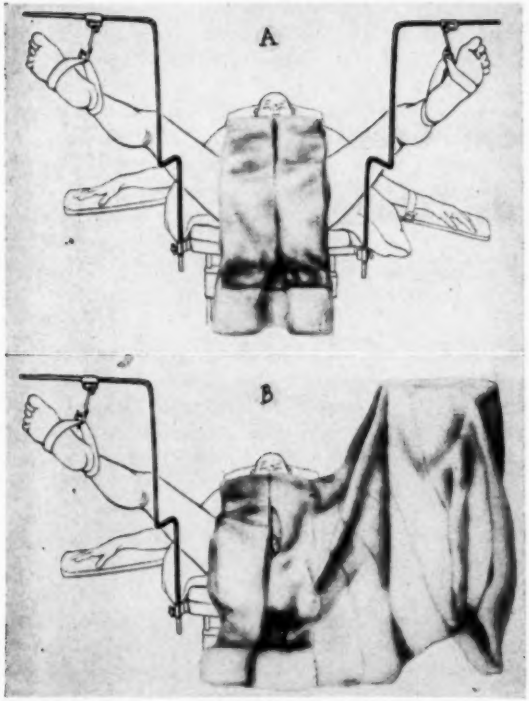


Figure 3

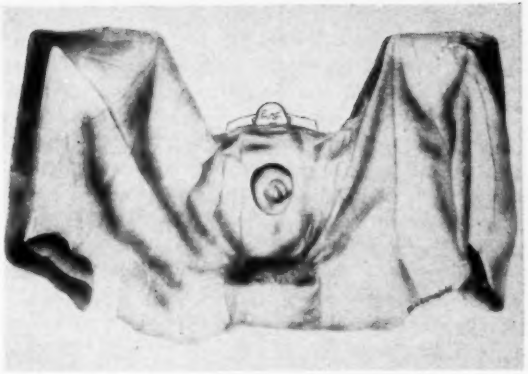


Figure 4

To drape the patient one first pulls out the drain pan. The folded drape is now placed upon the patient's genitalia with the opening for the genitalia overlying the genitalia (fig. 2, A). The end of the drape presenting anteriorly is thrown cephalad (fig. 2, B) and then the lower end incorporating the mesh is unfolded upon the pan (fig. 3, A). The left leg piece is placed over the left lower extremity (fig. 3, B) and positioning of the right leg sheet completes the draping (fig. 4).

A model drape will be loaned on request.

Cystoscopic "Boom" Enables Control of Cords, Tubing

To solve the problem of entanglement of cords and water tubing during endoscopic procedures, particularly during transurethral surgery, Moreton A. Magid, M.D., a urologist in Waco, Tex., adapted a microphone boom to control these elements.

In an article for the *Journal of Urology*, Dr. Magid declares that perhaps nothing has been more exasperating to the transurethral resectionist than the constant battle to maintain the correct length of the cystoscopic light cord, the radio frequency cord, and the water source. These three elements, he points out, have constantly been either too short or too long. Excess tension developed on one or the other with inequality of weight and length causes undue tension upon the resectoscope.

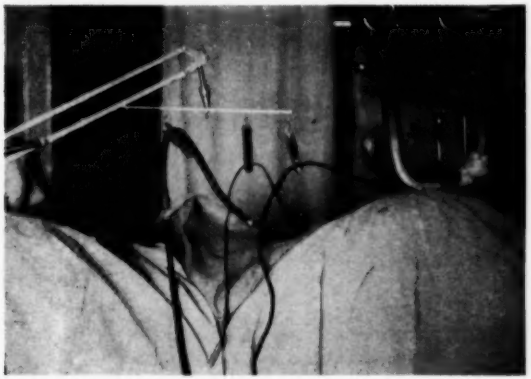
In his search for a better means of controlling these elements, Dr. Magid first tried suspending the elements by grouped rubber bands above the patient's pubic area. Though this worked fairly well, the elements were never evenly balanced.

"If all elements were of equal length then, when the working element of the resectoscope was completely removed, the light cord was too short. When left long enough for the maneuver, then it dropped over the eye piece or was in the way of the working element," Dr. Magid comments in the *Journal* article.

*"A New Boom for Cystoscopic Procedures," by Moreton A. Magid, M.D. The *Journal of Urology* 82:1, July, 1959. The photographs which appeared with Dr. Magid's original article are reproduced here through the courtesy of the Williams & Wilkins Co., publishers of the *Journal of Urology*.

The Foley arm, which was designed to carry the water, light and radio frequency cords, was found to lack flexibility. Because the light cord can pick up radio frequency energy, it should not be in too close proximity to the radio frequency cord from the surgical unit, Dr. Magid warns. Furthermore, the light cord should not run in metal tubing, because the cystoscope bulb will brighten when the radio frequency unit is energized and burn out if the absorption is too great.

In addition, Dr. Magid points out, the cord from the electrosurgical unit should not be encased in the metal tubing because the capacity effect would be great enough, at the high frequency generated, to cause the current to be by-passed to the ground, and, in turn, there would be lack of cutting or coagulation.



Dr. Magid decided to try some sort of boom to control these extra cystoscopic elements. He investigated several different types which he found unsatisfactory. Though all were adjustable, after being adjusted they were fixed in position and did not have the necessary mobility.

Finally, a microphone boom which is manufactured commercially gave him the results he wanted. The "cystoscopic boom" which he devised is mounted on a C clamp and swivels freely on a central axis. The boom's double frame is spring-loaded so that it maintains its position and may be changed to any new position with the slightest pressure.

The tubing and cord-holding mechanism was made from a one-foot piece of aluminum with eyes to hold plastic clothespins. The elements are well controlled, as the accompanying illustrations show.

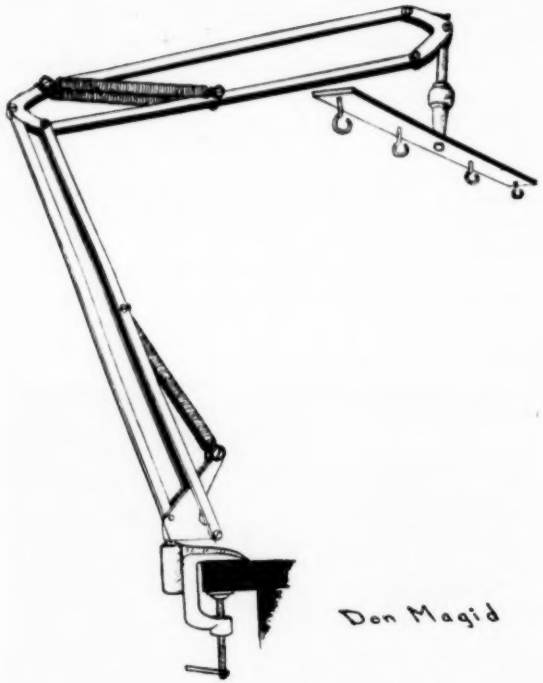
In usage, the boom is clamped to the film tray of the cystoscopic table. The cassette carriers are withdrawn approximately two inches. After the patient is prepared, the sterile clothespins are engaged on their individual hook-eyes and the cords are clamped one foot from their ends. The cords are

attached to the resectoscope; the boom is raised to extend the cords, and then is set to have the slightest positive loading.

The boom follows the operator through the resection, swinging outwardly when the resectoscope is removed and toward the patient's head when it is replaced. The boom raises and lowers with the slightest pull on the cords. The cords and tubing are always out of the way.

The advantage of this equipment, says Dr. Magid, is that the boom holds the cords at the proper levels and seems to swing with the resectoscope. The cords are set at the proper lengths, and the boom, at the completion of or during the procedure, may be elevated in order to hold the resectoscope without additional support. With slight relaxation of the boom, the cords are very flexible and follow the instrument.

The equipment has been in constant use for four years at two Waco hospitals, and has given "the ultimate in satisfaction," according to Dr. Magid. There has been no maintenance problem with it, other than the occasional replacement of a plastic clothespin. Several booms have been made for urologists in nearby cities, and they too have been most pleased with the equipment



Cystoscopic Ureteral Catheter Holder*

By George G. Gilbert, M.D.**

The need for, and convenience of, a cystoscopic ureteral catheter holder have seemed great. After many accidental contaminations of ureteral catheters, all the way from the patient's abdomen to the cystoscopist's eyebrow, exasperation led to the development of this ureteral catheter holder.

The metal of the instrument (fig. 1) has all the same qualities of that in the cystoscopes themselves. The sleeves through which the catheters run will accommodate all sizes up to 12F. The sleeves are mounted on ball and socket joints, allowing choice of any desired angle. The upper branches of the Y may be swung through an arc from the upright position to one about parallel to the stem of the Y. The semicircular band which clamps on the various instruments as shown in all the illustrations may be tightened securely with the hand screw. The holder fits all standard sized catheterizing telescopes of the Brown-Buerger type (fig. 2, A) and all sizes of McCarthy panendoscope sheaths (fig. 2, B). The holder is not adaptable to the various children's or infant cystoscopes. With both branches of the Y collapsed against the stem,

*Reprinted with permission from *The Journal of Urology*, Vol. 82, No. 6, December 1959.
**309 Doctors Bldg., Asheville, N. C.

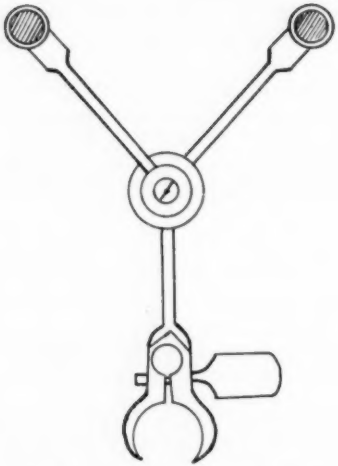


Fig. 1: End-on view of ureteral catheter holder.

the instrument takes very little space. As a result, it is conveniently stored and transported.

Many cystoscopies throughout the country are carried out entirely by the operator, particularly those done in the urologist's office. Besides, most office cystoscopies are performed with nonsterile drapes. This is not an ideal situation, but where that condition obtains, this catheter holder mini-

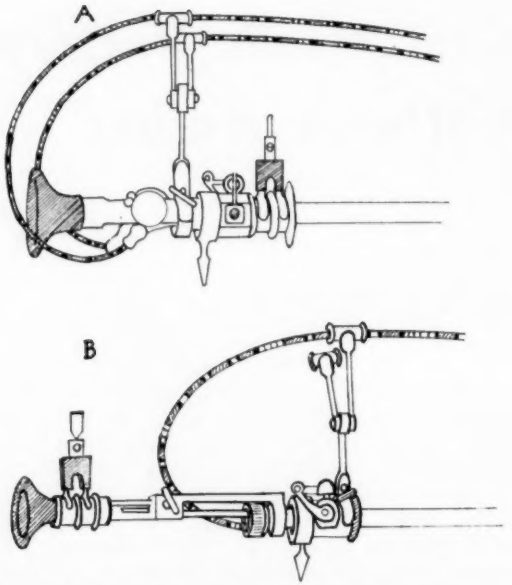


Fig. 2, A: Catheter holder with Brown-Buerger cystoscope. B: Catheter holder on McCarthy panendoscope.

mizes the risk of contamination. Under ideal conditions, with complete sterile technic and trained assistants, the holder is still very helpful purely as a convenience in the multitudinous niceties of manipulation of ureteral catheters and bougies. Admittedly, where the situation calls for a lot of twisting of the larger sized catheters, the holder limits freedom of such movements. The same limitation has been encountered with stone baskets.

As with all instruments, care and patience are rewarding in getting maximum efficiency. Any experienced cystoscopist will automatically make minor adaptations. Using the Brown-Buerger instruments (fig. 2, A) a little care is necessary to keep the curve of the catheter from touching the forehead and eyebrows. This seems best achieved by having the catheter run between the middle and index finger. There is much less risk of this with the pandendoscopes (fig. 2, B).

The incredible ability of Mr. Frederick Wallace and his ACMI associates to put together such an instrument from crude drawing and description is part of the reason for expressing thanks. Their cooperation and speed in manufacturing an original and one modification were equally amazing and a source of gratitude. Thanks are also due to Mrs. Dorothy Whitlock for the clear illustrations.

Self-Evaluation Important Feature of Our Elective O.R. Experience

By Joanne Michelson, R.N.*

Elective experience in the operating room offers the senior student an opportunity to apply managerial skills in the presence of junior students, practical nurses, technicians, and aides. The student becomes more aware of personnel problems, maintenance and economy, hospital policies, and their importance in an efficiently managed operating room.

An important part of the elective experience at the St. Lawrence Hospital School of Nursing is self-evaluation by the student. When she comes to the department, she is handed a folder to be completed before she leaves. This folder contains:

1. A pre-test given to all students, which has been enlarged to stimulate thought on a management or head-nurse level.

2. A technic evaluation form for self-evaluation on two major cases, one on which she works with another nurse and one on which she works as first scrub nurse (see page 70).

3. A technic evaluation form for evaluation of a student on similar cases, but on different days, so that the student will become aware of the effect of personal feelings and circumstances on efficiency. (Form used is the same one used for No. 2.)

4. A self-evaluation form to be turned in at the school office, on which the student accounts for time in the department and experience assignment, rates herself on personal characteristics, tech-

*Operating-room clinical instructor, St. Lawrence School of Nursing, Lansing, Mich.

nical performance, relation to surgery personnel and student group, professional conduct, and relationship to administrative and teaching staff, and gives herself the final over-all mark she thinks is fair. (See sample of completed form, page 72.)

5. A hypothetical staff situation, on the basis of which the student is to arrange a time schedule for one month.

6. A questionnaire on her experience.

These project assignments are in the right-hand pocket of the folder. In the left-hand pocket is subject material to be read and discussed thoroughly: an outline for the elective experience, information on observational technics in evaluation of students, and an explanation of essentials in team nursing for daily patient care.

When the senior student comes to the operating room for her one-month elective experience, she has already spent eight weeks there on required rotation as a junior student. She may be only one month into her senior year or may be within a month or so of graduation, depending on the rotation. Approximately eight to twelve months elapse between her required and elective experience.

The rotation offers elective choice to groups of three to six at a time, and out of each grouping we receive one or two students, but arrange to have only one in the department at a time.

There are seven rooms in our O.R. suite, including a cystoscopy room. The staff works a 40-hour week, and we have one graduate and one student working 3-11 p.m. The rest of the staff is on duty from 7:30 to 3.

The average case total is approximately 500 per month. All supplies are prepared and sterilized in the O.R. suite.

The elective student works in each area to gain insight into the problems involved in ordering, preparing, sterilizing and storing supplies. She also has an opportunity to develop proficiency in applying the basic principles of aseptic technic if she shows aptitude and interest, or if she feels a need for more experience in this area.

Teaching methods used include: observation and review of basic principles; demonstration and return demonstration; a field trip to another hospital for observation of its procedures.

The student is evaluated by means of the pretest (see page 76), hypothetical situation problems, and anecdotal records.

Our general aims and objectives are:

1. To help the student develop an appreciation of management problems and to give her an opportunity to learn and apply managerial skills.

2. To further develop the ability to cope with emergency situations.

3. To acquaint the student with the graduate nurse's responsibility toward the patient, surgeon, and hospital.

4. To develop in her an appreciation for the need of teamwork and cooperation, and give her an opportunity to exercise leadership in planning and organization of work assignments.

5. To help her gain insight into problems of personnel management, and to be aware of the operating room in relation to other departments in the hospital.

6. To give the student an opportunity to develop in an area in which she feels she is deficient.

7. To develop additional skill in applying the principles of aseptic technic.

8. To stimulate the student's interest in the area in which she shows ability and/or a desire to know more about other than on a student level.

These objectives are facilitated by:

—Assignment with the department supervisor, to develop an understanding of the necessity for economy with efficiency, maintained through effective management.

—Assignment with the head nurse, to make the student aware of the importance in line of authority and make her understand how efficiency through planning and ordering of supplies is maintained by allocation of duties by the supervisor through the head nurse.

—Assignment with practical nurses so that she will understand their duties in the department, as well as the part played in over-all patient care and student education.

—Assignment as team leader of junior students to develop leadership and organizational skills as well as teach her to apply fair, objective evaluation.

—Assignment to apply principles of aseptic technic through the duties of the circulating nurse.

—Allowing the student to select the type of cases on which she wants to scrub when she is not assigned to other cases or other duties.

—Making a visit to another teaching hospital to observe physical organization of the operating room, personnel policies, methods for control of the schedule and management of the department, supervision of nonprofessional personnel, and other O.R. functions (see outline for field trip to Edward W. Sparrow Hospital).

The enthusiasm of students for the elective experience was evident in the answers we received to a questionnaire sent to all graduates who spent additional time in the operating room as elective students, and to all senior students who had completed the elective service at the time this article was prepared. The questions – and some of the answers received – were as follows:

1. What have you learned from your experience that you hadn't expected to learn?

"The importance of and function of the operating room in hospital economy."

"How the department is managed in regard to scheduling of graduates, aides, all personnel, purchasing supplies, and duties of the personnel."

"That I can work in an operating room in a capacity other than as a regular student. . . I got a chance to see how well I can assign work, evaluate myself, and have leadership ability."

2. Are there things you didn't learn that you wanted to know about? List and explain.

"I would have liked to have more opportunity to circulate". . . . "more experience operating the autoclave" . . . . "more experience scrubbing on cases" . . . . "more experience making out schedules, ordering supplies, (learning about) economy in the operating room."

3. What are your reasons for electing additional time in the operating room?

"I am interested in the operating room and wanted to know if it is the field of nursing I want to work in as a graduate."

"I wanted experience in running a department, (in dealing with) problems with some personnel . . . needed to have some understanding of how to fairly evaluate people."

4. Evaluate an elective experience in view of nursing-school curriculum. Does it stimulate interest, etc.?

"I feel that (because of) having a chance to pick an area for one month, the student will be interested, will develop self-confidence, and maybe increase dexterity. Even if she doesn't do well in the operating room, she will want to know about management."

"It gives self-confidence, initiative, and skill, and should be offered to all students.

5. Do you have any suggestions that you feel would make this program more interesting and of more value?

"I think it would be interesting to see if the senior student could act as supervisor for a few days or one week, make assignments, order supplies—not just observe the supervisor on certain days that special duties are carried out."

"I think (it would help) if we had some sort of project to make – possibly a teaching aid, a model of table set-ups – a theme to clarify something that was difficult for us as junior students. This way we would not just take from the experience, but contribute to other students' learning and enjoyment of the service."

One student, on her self-evaluation sheet, made a comment which sums up very well the reactions of students to their elective experience:

"I feel that my elective time in surgery has been well spent and rewarding. It gave me an opportunity not only to improve my skills but to

"... One more 'OOPS' from up there and I shall be forced to discontinue! ..."

Courtesy George Lichty, Chicago Sun-Times Syndicate.

learn something about O.R. administration. As a student on rotation, I was too concerned with learning basic technics to have time to receive much insight into the other aspects of O.R."

Student's Check List

100% Possible

I. Organization – 10%

A. Equipment needed
B. Doctor's card
C. Assistance before case

II. Scrub technic – 10%

A. Principle carried out
   1. Circular motion
   2. Nails clean and trimmed
   3. Technic carried out

III. Towel, gown and glove technic – 15%

A. Principle
   1. Water droplets
   2. Gowning self
   3. Gloves
      a. Powder
      b. Turning cuff
      c. Without rolling

IV. Organization and planning – 15%

A. Clearing of table
B. Evidence of planning
C. Set up as required
D. Wasted motions
E. Improvements in procedure

V. Suture technic – 5%

A. Broken glass
B. Handling of material
C. Organizing type and usage

VI. Assistance of surgeon

A. Gowning and gloving of other personnel
B. Handling of linens
C. Passing of instruments

VII. Dexterity – 15%

A. Foresee doctor's needs
B. Attentive and act on direction
C. Conscious of surroundings
   1. Other conversation
   2. Patient's welfare – anesthetist
   3. Direction from circulating nurse

VIII. Complete awareness of technic – 15%

A. Sponge count
B. Sterile area – moisture, sutures, packs
C. Skin, knife and specimen
D. Teamwork

IX. Teamwork – 10%

A. Planning and organization
B. Cleaning of room between cases
C. Professional attitude
   1. Conversation
   2. Conduct
   3. Questions to doctor about
      a. Anatomy
      b. Procedure
      c. Prognosis, etc.

EXAMPLE OF SCORING:

Section I – only 5% given because student was not aware of basic equipment needed, was depending on others to do it, and was not helpful in a morning case but gave good cooperation between cases.

Section IX – full 10% given because student was very helpful and dependable. Her conduct could have been more professional at times, but she showed an interest in the patient's condition and the anatomy involved, asking intelligent, pertinent questions. She could see the relationship between O.R. procedures and postoperative care.

Self-Evaluation Form

Name of Student *Joan D.* Class *O. R. Elective*

Inclusive Dates ..... Clinical Experience .....

Lecture Hours ..... Time Allotment: days ..... call ..... off ..... total .....

Marks: theory ..... practice ..... final mark .....

Experience: majors ..... minors ..... circulations .....

I. Personal characteristics 1 2 3 4 5
I have trouble working closely with others. I feel that I'm more at ease with people now and am learning to know and let people know me. I am neat in appearance, quiet and considerate. 3

II. Technical performance 1 2 3 4 5
I have developed some speed and dexterity, value the honesty necessary in O.R. nursing, know why, not just how to do a procedure. 4

III. Relation to surgery personnel 1 2 3 4 5
Work cooperatively with the staff of any level, feel free to ask for help if necessary, can give directions to nonprofessional help without being bossy. 3

IV. Relation to student group 1 2 3 4 5
I tried to be helpful, gave directions and assignments fairly. I think the junior students felt free to ask questions or work with me as a leader to get a job done. 4

V. Professional conduct 1 2 3 4 5
I find it difficult to be professional in some people's presence, but am trying to hit a happy medium in being friendly but not familiar. 3

VI. Relationship to administrative and teaching staff 1 2 3 4 5

I can now see some of the problems of the staff and the instructor and try to do my part as a student on returning to the department. 4

1–failure; 2–below average; 3–average; 4–above average; 5–superior

GUIDE:

I–Maturity, dependability, (ability to make) decisions, completion of work, composure, time-wasting, neatness, laziness, punctuality.

II–Knowledge of aseptic technic principles and ability to carry out as taught, organization, (amount of) supervision needed, completeness and conciseness.

III–Personality compatibility, adjustment to situations, thoughtfulness of others, (ability to) learn from others, acceptance of criticism and direction.

IV–Initiative, assuming of responsibility for own learning, acceptance by others, leadership qualities.

V–Timely humor, intelligent conversation, courtesy, acceptable conduct, application of good moral principles in her work.

VI–Showing of interest, deriving satisfaction from work, acceptance of constructive criticism, contributing to as well as taking from learning experiences.

Miss D.'s grade is computed as follows:

3 x 3= 9 (for the three questions which she answered with "3")

3 x 4=12 (for the three questions which she answered with "4")

$\overline{21} \div 6 = 3.5$, or B–

Instructor's comments: "This student has shown progress in adapting to varied situations, has really tried to be a leader of the student team. She is potentially a very competent and objective person and has graded herself accurately, and the evaluation is clear and well written."

Guide to Field Trip

Edward W. Sparrow Hospital Operating Room

I. Physical location – advantages and disadvantages in relation to:

a. Pathology laboratory
b. Emergency room
c. X-ray
d. Laundry
e. Elevators
f. Recovery room

II. Accommodations – advantages and disadvantages

a. Postoperative recovery room, how large, who staffs, length of patient stay
b. Elevators – for surgical patients pre- and postoperatively; near or in O.R. suite?
c. Waiting rooms
d. Dressing rooms for staff and surgeons
e. Telephones in suite–where, how many
f. Signals – lights or buzzers outside rooms

III. Personnel

a. R. N. – duties, hours, rotate shifts?
b. S.N. – duties, hours, classes?
c. L.P.N. – same
d. S.P.N. – duties, hours, classes?
e. Technicians – same
f. Aides
g. Orderly
h. Janitor

IV. Personnel policies

a. R.N. – pay for call, vacation time?
b. S.N. – work for pay on days off – in O.R.? Hours week, 3-11 duty, time back for call?
c. Inservice education – all new staff?

V. Education program

a. Interns – who instructs?
b. Students – class hours out of department, classes in aseptic technic while in department
c. Aseptic theory and practice under same person, how many hours, theory before or with practice?
d. Line of authority from head nurse up, and downward from H.N. to janitor
e. Whom are students responsible to?

VI. Schedule

a. Confine certain type case to certain room?
b. Who controls schedule – does scheduling? Advantages of this?
c. Record of anesthetists on schedule

VII. Management

a. Who is responsible for stocking and supplying special equipment in each room?
b. Who checks anesthesia machines, suction and Bovie machines?
c. Linens – folded and wrapped by whom, where?
d. Basin sets, instrument trays – wrapped and sterilized in O.R.?
e. Cupboards and rooms cleaned by whom?
f. Who is responsible for running the autoclave and for repairing it?
g. Who orders supplies from C.S., pharmacy, and stock storage (sub-basement)?

VIII. Sterilization

a. Chemicals used?
For what supplies, for how long?
b. Autoclave
Types used, by whom, for what supplies?
c. Washer-sterilizer – advantages, etc.
d. Care of contaminated case equipment

IX. Safety

a. Fire extinguishers – type and where located
b. Electrical outlets – location and type
c. Fire-alarm system – type and location
d. Linen chute – fireproofed? How?
e. Steam penetration indicators
f. Anesthetic gases – storage
g. Precautions for use of cyclopropane
h. Electric spark prevention and control
i. Contaminated linen – discuss!
j. Autoclave graph – in O.R. and C.S. for legal proof of equipment operation?

General Topics

a. Hospital head nurse and staff meetings – general problems
b. Department personnel meetings for department problems
c. Assignment to graduates and students –by whom?
d. Duties of graduates, scrub, circulate, etc.?
e. Membership in district O.R. section and/or interest in Association of Operating Room Nurses
f. Arrangements of time schedule–by whom?
g. Charges to patient – how determined, advantages and disadvantages in method
h. Facilities – permanent suction and 0_2
i. Unusual occurrence reports
j. Storage of supplies – like our cupboards?
k. Skin preps – done by whom? Where and when?

Aseptic Technic Pre-Test

The objective of the test is to determine the amount of material retained in the basic sciences, and to determine your ability to integrate them in total patient care.

1. What is the effect of atropine on the body, and what is its purpose in surgical procedures?

2. What is the reason for giving a preoperative medication?

3. Give two examples of a combined preoperative medication.

4. What is the most resistant type organism to sterilization by heat and/or chemicals?

5. Give the generic name of the organism normally found on the skin surface that causes stitch abscess or wound infections.

6. Why is a skin prep done the evening before surgery?

7. Which is the most effective in destroying spore-forming bacteria: autoclaving or boiling?

8. When transferring a patient to the O.R. table, what are some points to remember?

9. Why is it desirable to cleanse at least one fingernail of polish before the patient is going to have an anesthetic?

10. What anatomical structures would be severed or separated before opening the peritoneum for an appendectomy?

11. Without the use of a soda lime absorber on the anesthetic machine, the patient during an inhalation anesthetic would become toxic and expire from carbon monoxide or carbon dioxide poisoning. Choose one.

12. What type of nerve damage would result from a forearm hyperextension, and what would be the visible effect postoperatively?

13. If a person is inadequately prepared for surgery, has no understanding of the surgery to be done, his condition before, and what to expect postoperatively, the excitement stage is exaggerated during anesthesia. What effect would this have on the parasympathetics?

14. How would you assure a colostomy patient preoperatively, when he asks about the condition, how long it will take, what is to be done, how he will

be cared for postoperatively, and what he will have to learn about his own hygiene on discharge?

15. Discuss the religious aspect preoperatively.
   a. Awareness of patient's need.
   b. How to contact patient's pastor (priest or minister).
   c. What can a nurse contribute to a patient's spiritual well-being?
   d. How can a nurse reassure the patient of God's presence and vigilance in all situations?

16. Discuss aseptic technic, medically and surgically, in regard to symbolic illustration.
Keep out ☐ Keep in ☐

17. Why is the operating room an increased fire hazard?

18. Where is the fire extinguisher near the O.R. suite, and when was it last inspected? Who is responsible for this?

19. How would you receive the notice that a marked increase in postoperative infections has occurred? What things would you consider in attempting to trace and control this development?

20. What would you do in this situation: Two weeks in advance you were notified that there would be a shortage of three graduates when six are usually needed.

21. How would you cope with this situation: A graduate, whose duty it is to circulate in a certain room, is having personality conflict with the student. The student needs the experience and must be assigned to this area.

22. If a patient (either Catholic or non-Catholic) expires while in the operating room, what is the responsibility – professional and/or moral – of the nurse, whether Catholic or not? The patient might be a one-week-old infant, an adult, or a newborn delivered by cesarean section.

23. In the following situation, how would you attempt to make improvements: As the head nurse on a surgical ward, you are aware of a severe inadequacy of suction equipment. Some machines are in poor repair and not dependable – besides the fact that there is an insufficient number of machines compared to the need.

24. Give two or three reasons why you have elected more time in the operating room.

25. What do you hope to learn from this experience, and what activities or projects could help you in this area – beyond the level of primary experience as a student in the O.R.?

Review of Hospital Lawsuits

By Leo T. Parker, Attorney at Law

Control Fixes Liability

A hospital official asks: "Can you outline either peculiar or usual circumstances under which a hospital operated for profit is not liable nor responsible for injuries caused by negligence of an employee of the hospital?"

Modern higher courts consistently hold that an employer is not liable in damages for injuries caused by a negligent employee who was under control of another party at the time of the injury.

In *McCowen v. Most Precious Hospital, 253 Pac. (2d) 830,* the testimony revealed that a woman named McCowen was admitted to a hospital for surgery to be performed by her personal physician, Dr. Puckett. She was prepared and taken to the operating room by nurses and attendants employed by the hospital. She was placed upon an operating table and given a spinal block by her physician.

Later he left the nurses in charge of the patient, after directing them what to do, and went into an adjoining room in preparation for the operation. During his absence, the nurses permitted Mrs. McCowen to fall, and she suffered severe injuries.

The patient sued for heavy damages. The higher court decided that when a nurse employed and paid by the hospital is under the operating surgeon's special supervision and control, the sur-

geon is solely liable for injuries to the patient caused by the nurse's negligence. The court said:

> **"The rule deduced is that where a hospital nurse, although not in the regular employ of the operating surgeon, is under his special supervision and control during the operation, the relationship of master and servant exists and the surgeon is liable."**

If a nurse is under the control, direction or orders of a private physician or surgeon at the time she negligently causes injuries to a patient, the court said, the hospital automatically is relieved from liability, although the nurse is a hospital employee.

(The following material appeared in the "Questions and Answers" department of the May 16, 1959 issue of the Journal of the American Medical Association, *and is reprinted here with the permission of the editors.)*

Duties of Operating-Room Nurse

Q. An anesthesiologist who recently began private practice in a small city had, all through his training, taken the duties of the circulating nurse in the operating room pretty much for granted, especially in regard to the anesthesiologist. This was challenged recently by the operating-room supervisor, and the chief of surgery and the anesthesiologist are now interested in having some references that may have been proposed in the past in answer to the question, "What are the duties of a circulating nurse in an operating room?"

For example, during induction, it has always seemed a wise policy to have either the surgeon or his assistant in the room, with the circulating nurse right by the side of the patient, preferably on the side with the intravenous apparatus. The supervisor states that the circulating nurse should have no part in this role.

Surely this attitude cannot be in the best interest of the patient. Please give an opinion for presentation at the next surgical staff conference.

A. In a well-known general hospital, the duties of the circulating nurse are not described in a manner limiting her only to the duties associated with the operation. She is available to help the anesthesiologist if he needs her help, but too frequently she is expected to do many of the routine things that the anesthesiologist should do for himself, such as having syringes, ampuls of various medicaments, intratracheal tubes, and laryngoscopes immediately available and his gas machine opened up for use.

The circulating nurse should not be expected to do many of these routine things, but she might be expected to lend a hand to the anesthesiologist if it would be of some assistance to him.

(Abstract of a paper presented at the 1960 Tri-State Hospital Assembly)

Barrier to Communication Is Guessing; Not Knowing

From the point of view of the supervisor, "trouble-makers" are those who don't follow orders, who don't listen well, and do poor work as a result. To fire such people is not the solution to the problem created. It may be a speaker/listener problem, in which case the source of trouble is in the communication process itself.

Many of the barriers which cause breakdown may be attributed to the frequency with which we use guesses as statements of fact. English grammar makes this easy, for a declarative statement such as "the apple is delicious," which is a guess or inference if merely based on observation, sounds as true as "the apple is red," a fact based on observation. When people act as if an inference is a fact, they are confident, jump to conclusions, fail to check, and act according to their assumption. The long-held belief that the world was flat, and the statement that the Titanic was an unsinkable ship, are famous examples of this rule in action.

Difficulties increase when people fail to size up what other people mean. Words are like maps; they merely signify objects, and are translated differently by different people. To avoid jumping to conclusions, we should ask ourselves and others for clarification. Language is a tool, and as such, has limitations. We can be aware of these by developing a persistently questioning attitude. – *Park G. Burgess,* assistant professor of speech, Northwestern University, Evanston, Ill.

SELECTED BIBLIOGRAPHY

By Dorothy W. Errera, R.N.

Management

McClellan, James T.: "The Surgeon's Responsibility for the Surgical Specimen." *J. Kentucky Med. Assoc.* 57:1192, October, 1959.

A few suggestions made for the care and handling of surgical specimens in hospitals without a department of pathology are:

Identification of the specimen should include: the patient's name (for a woman, one should use her legal name, plus the given name of her husband in parenthesis); the patient's age—if it is unknown, some approximation should be made, as "child," "adult," "50 plus," etc.; date of surgery—this is important if the pathology report is to appear in the patient's history in proper sequence; the patient's sex and race; the hospital's name and specific address to which the report is to be sent.

Preoperative and postoperative diagnosis are very helpful to the pathologist. If diagnosis is difficult, the surgeon should at least state his reasons for surgery. All tissues and organs removed should be listed whether or not they are diseased. The type of examination required should be specified. The surgeon's name (legibly written) should appear on the requisition.

If delivery to the pathology laboratory is to be delayed, the specimen is placed in fixing solution and labeled with the patient's name, the nature of the specimen, and the physician's name. This is imperative to protect surgeons, hospitals, and specimens from hopeless mix-ups.

When a specimen is fixed, it hardens. It is important, therefore, that specimens be placed in containers large enough to allow the pathologist to remove the specimen without breaking the container. Generally, a container 10 times the volume of the specimen is adequate.

Ten percent formalin is a good fixing solution. It can be made by mixing one part of commercial formalin (37-40% formaldehyde) with nine parts of tap water. In many communities, drug stores can supply the formalin.

Alcohol is *not* a satisfactory fixative. It dehydrates specimens so that they become hard and brittle. Also, because it has no penetrating action, only surfaces are fixed. If formalin solution is not available, arterial embalming fluid is a better substitute than alcohol.

Fixing solution coagulates the tissue proteins; hence, the solution must reach all the tissues. A specimen should

never be wrapped tightly in gauze before immersion in fixing solution. Whenever possible, the tissue is removed from the gauze which receives the specimen at the operating table. If this is not practical, the gauze and specimen are placed in a container large enough to allow the gauze to fluff out and make the specimen accessible to the fixing solution.

Large specimens should be sectioned neatly and hollow viscera opened and flushed out so that fixing solution can penetrate the mucosa.

A specimen is prepared for mailing by rinsing it in cold tap water and sectioning or opening it as necessary. The tag is affixed to an unimportant part of the specimen. The specimen is suspended in a large container of formalin for 24 hours or more until fixing is complete. Specimens are placed in plastic bags with small amounts of formalin solution. The bags are tied snugly and mailed to the pathologist.

If a specimen is to be submitted fresh, it should *not* be placed in water or saline and should be delivered promptly to the pathologist.

Sakson, John A.: "A Simple, Inexpensive Debridement Stand." *AMA Arch. Surg.* 80:305, February, 1960.

A debridement pan that can be made in the hospital workshop simply and inexpensively is described. Needed for its construction are:

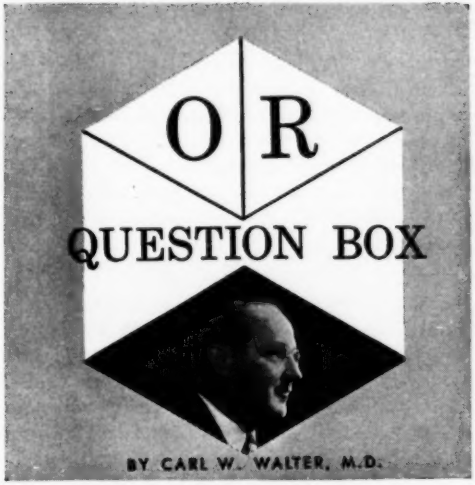
1. An old bedside stand or Mayo with adjustable height.
2. An ordinary baking pan, 14 x 10 x 4 ($1.49).
3. Four inches of ¾" copper pipe.
4. Chrome-plated refrigerator grill shelf (49c).
5. Screw hook for suspending bucket.

Directions: (1) Cut tray of stand to fit bottom of baking pan; (2) drill hole through pan and tray; (3) solder ¾" copper pipe to hole, and (4) suspend bucket under tray on hook to catch irrigating solution.

E. G. Rees Jones: "A Screen for Use During Thoracic Operations." *Lancet* 1:1392, June 25, 1960.

A screen is described which allows unrestricted access to the patient's face and keeps assistants off the patient's face and neck. It is a rectangle of wood 10 x 22", faced with Formica. The rectangle is attached to a knuckle joint with a fore and aft tilt of 270°, and the joint is attached on a pillar 20" long.

The whole device is clamped to the side rail of the table behind the head of the patient, who is in the lateral position. It is moved up or down or tilted until the position is correct and is then draped.



Assisted by Dorothy W. Errera, R.N.

Q. Our anesthetists will not allow airways or endotracheal tubes to be autoclaved. Do you approve if they are adequately cleaned?

A. The tubercle bacillus is the most dangerous potential contaminant of anesthesia equipment. This organism is destroyed by many germicides typified by the alcohols, iodophors and synthetic phenolics. All are good fat solvents and hence capable of penetrating the organism's capsule. These germicides are also effective against a wide range of vegetative organisms.

Besides protection of the patient from contamination, another concern is protection of personnel. They must be cautioned to immerse soiled equipment in germicide immediately after use, and postpone cleaning until there has been adequate exposure to the germicide.

Q. Does it do any good to wear conductive-soled shoes on a nonconductive floor?

A. There is only safety in this situation if the floor is continuously mopped and kept wet.

Q. When patients in the recovery room are positioned with their heads away from the wall, is there any hazard in using the piped oxygen and suction?

A. No. Four extra feet of tubing are usually needed.

Q. We have gone to the expense of putting in conductive floors in our new operating rooms. We have required all personnel and doctors to wear conductive shoes. We have bought con-

ductive rubber for suction tubing. Now the doctors say the tubing is too stiff and won't use it. Aren't we defeating the good of all we have done by going back to latex rubber?

A. Suction tubing need not be of conductive rubber. It is usually moist after sterilization, and sucking a few cc. of water through it before beginning surgery makes it safe for use in the presence of a combustible anesthetic.

Q. Is there an established practice or technic for sponge count? We use all radiopaque sponges and in case of a miscount usually take x-rays. Is any other precaution necessary?

A. Only radiopaque sponges should be used in the operating room. These can be purchased in pre-counted packages so that the accuracy of a machine count is the basis for the sponge count. Each scrub nurse is supplied with intact packages. She can check the count at the onset of the operation and whenever additional packages are supplied to her.

As sponges are discarded from the field, they are collected in a basin for subsequent discard into a kick pail. The circulating nurse can easily count the sponges from the kick pail into a waterproof bag of either paper or polyethylene. This can be done with transfer forceps to avoid contact with tissue, fluid, or blood. It is convenient to count 10 sponges into each bag so that the ultimate count can be arrived at quickly.

The ultimate responsibility for the removal of instruments, sponges, and the like lies with the surgeon. The scrub nurse and circulating nurse are his responsible assistants in determining the accuracy of the count. It is usually a simple matter to find a lost sponge by exploration of the wound. If, however, it cannot be found in this way, x-ray is relied upon to establish its presence or absence.

An alert scrub nurse can do a great deal to help keep track of sponges by checking them on and off the field so that there is none left in the wound unwittingly. Whenever sponges are used as packing, they can be marked with hemostats so that their location is obvious.

Q. Is it an acceptable procedure to wash the bloody instruments during an operation in the same basin that one used for moistening sponges? If not, what does one do to rid instruments of tissue and blood before returning them for reuse in the field?

A. Rinsing soiled instruments in the sponge basin during a procedure presents no great hazard unless malignancy or infection is encountered. The solution, however, becomes a mess and sponges pick up annoying bits of tissue and mucus. Also, wound

irrigating solutions have a saline base and this is a substance very corrosive to instruments. A better solution is to have a separate basin of solution for rinsing soiled instruments. The aqueous quaternaries are good for this purpose, being nontoxic when residuals are carried into the wound and having some detergency to aid in keeping instruments clean.

Q. Our surgeon would like to know how blood loss should be determined during surgery.

A. Measuring blood loss during surgery can be a complicated procedure or can be a fairly simple procedure depending on how accurate a measurement one wants and how well qualified the operating-room personnel are who are charged with the responsibility. Radioactive isotopes may be used or special suction apparatus. In one simple method, blood in the suction bottle is measured and blood in discharged sponges is measured. Your surgeon will find descriptions of blood-measuring technics in his professional journals and can make a choice depending on his surgical technics or philosophy of blood replacement.

Q. How do we ask the surgeon for a sponge count as the peritoneum is about to be closed? We have been saying . . . "Dr., do you have "x" number of sponges on the table?" . . . but many of our surgeons feel that the doctor is not participating in the count if asked in this way and could not be held legally responsible for a wrong count.

A. The patient's recovery is the surgeon's responsibility regardless of the jargon used for a sponge count. It is my own feeling that all sponges should be removed from the field as the peritoneum is about to be closed, counted and the field rehabilitated with clean sponges.

Q. Is there any system of charging for suture materials in surgery or a schedule for minimum and maximum amounts of sutures to be used? We feel that some of our surgeons use too much suture material and too many sponges. Perhaps, if they were charged for any used over a given number, they might cut down on waste.

A. The surgeon remains the boss but this is not to say that he cannot be approached for a discussion of what appears to be his abuse of economy. Such a matter is usually best handled by the chief of surgery after you provide him with good evidence to show that one surgeon uses an amount of suture material unrelated to the amount used by another surgeon for the same procedure. Often, the scrub nurse can control this problem by cutting

sutures to practical but not excessive lengths. If you can document your suspicions of needless waste, it may be indeed easier to charge the surgeon rather than make changes in a lifetime of suturing technics.

Q. What is the wet-bulb thermometer you refer to?

A. As water evaporates, it takes in heat from the surrounding air. The result is "evaporative cooling." A wet-bulb thermometer indicates the temperature that results from such evaporative cooling.

The mercury bulb of the thermometer is surrounded by a wick that sits in a water reservoir. As the wick soaks up the water, the water evaporates at a rate in keeping with the relative humidity of the atmosphere, and the mercury responds accordingly. The difference between the temperature indicated on a dry thermometer is an expression of relative humidity.

The "wet bulb" thermometer reading is a sensible temperature – that is, it reflects what the patient is feeling as he sweats; the sweat evaporates and his body cools.

Q.–We set up cases for the next day's schedule late in the afternoon of the day before. The tables are then draped with a heavy double twill drape. Would you please inform me whether the tables are still sterile the next day?

A. No matter how thoroughly sterile tables are draped, they are susceptible to contamination by curious people, insects, and harried personnel who in a panic will pirate supplies from a sterile table. Every patient has a right to an individually wrapped and sterilized kit which is opened at the time of use by competent personnel and supervised thereafter until the operation is completed. Little time is saved by using the technic you describe, and once open and left unguarded, no table can be considered sterile.

The "heavy double twill drape" you describe may be a hazard. These fabrics are usually heavy and coarse and have been shown to be impermeable to steam penetration.

Q. What is the Lane technic?

A. The Lane technic is a super-refinement of aseptic technic. It is a "no touch" technic used in the early 1900's by Sir Arbuthnot Lane, a British orthopedic surgeon. Instruments are used once and discarded; fingers are never allowed in the wound; tissues and bone are handled only with sterile instruments. It is a good technic for surgery when carcinoma is present because it prevents implants of malignant cells in the wound, but it

is not essential for clean cases in a modern operating room. It is used in only a few hospitals in the United States.

Q. Can sterile supplies be stored safely on open shelves in the operating room?

A. Air-borne bacteria are not the chief cause for concern in this instance. In a clean operating room, there is little dust to settle on exposed kits and packages. In an efficiently-run operating room, shelf stock is inventoried so that supplies are current. The sterile kit or package kept for occasional emergency use is protected with an outer wrapper of plastic or paper.

Sterile supplies on open shelves in an operating room where a septic case has been treated are in jeopardy only if they are within range of splashing from the field. Storage shelves at the periphery of the operating room are far enough removed from the focus of sepsis to be considered safe, provided that dust, lint and dirt are controlled with sanitizing housekeeping practices.

Insects and moisture constitute the major threat to sterile supplies. Wrappers may be wet with the excreta of insects, mouse urine, or condensate from air-conditioning ducts or cold water pipes. Sterile supplies on tables in sterilizing rooms are in particular peril because steam will condense on a cold ceiling, and the condensate will drip onto exposed sterile instruments or packages. The enthusiastic aide dusting shelves with a sopping wet sponge or rag is also a threat.

Insects, of course, are ubiquitous, and a continuing program of extermination is a must in almost any locale. Discipline and planning are needed to protect packages from the exterminator's spray or from seepage from a shelf imperceptibly moist with insecticide.

Q. How can an abscess be sterile?

A. A sterile metal implant in the body may be attacked by body fluids. Electrolysis occurs and an abscess results. There are no bacteria present—only chemical irritation around a foreign body which will eventually be extruded.

Conductive Flooring Serviceable As Well as Safe, Report Shows

The following summary of results of a detailed study on conductive flooring was prepared by the National Bureau of Standards.

Conductive flooring is as serviceable as non-conductive flooring of the same type, and it reduces explosion hazards, according to a recent National Bureau of Standards investigation[1] sponsored jointly by the Army, Navy, and Air Force. The Bureau also found that current methods for measuring the resistance of installed conductive floors reasonably simulate the conditions these floors meet in service. The investigation was carried out by T. Boone, F. Hermach, E. MacArthur, and R. McAuliff.

Although the flooring was investigated primarily for use in hospital operating rooms, many of the results obtained should apply equally well to floors that are used in other locations such as munition plants or storage depots for explosives. Consequently, architects may now choose conductive flooring materials for all these uses, within some limitations, on the basis of the behavior of similar non-conductive materials.

Explosive vapors are often present in operating rooms. If static electricity is allowed to accumulate, it can cause sparks having sufficient energy to ignite these vapors.[2] The most effective means for reducing this hazard is to keep the electrical resistance between objects in the area so low that the minimum sparking voltage (about 400 v) is never attained. Conductive flooring provides the necessary linkage because most objects normally rest or move upon the floor.

Electrical resistance of flooring material is generally lowered by adding carbon black, which is produced by thermally decomposing acetylene gas under carefully controlled conditions. Carbon black is dispersed in the mixes that are shipped for on-the-job composition of latex, concrete terrazzo, and the setting bed for the ceramic tile.

On the other hand, the carbon black is dispersed during manufacture in ceramic, linoleum, rubber, and vinyl flooring.

TESTING METHOD

Specifications and measurements of flooring resistance are usually made according to the method recommended by the National Fire Protection Association (NFPA). According to this method,[3] resistance is measured by means of a 500-v ohmmeter connected to two similar electrodes that simulate footwear and conductive rubber objects.

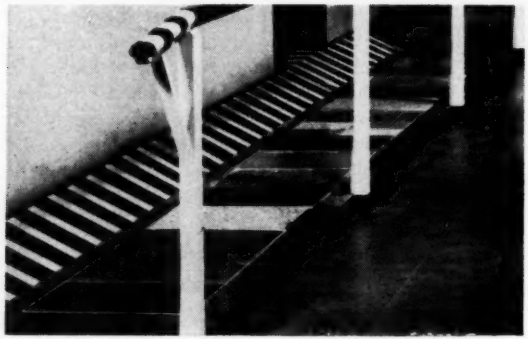
A conductive floor should have a resistance low enough to prevent the build-up of dangerous static-charge voltages, yet high enough to prevent sparks or severe shocks from electric power lines or equipment that might become defective. According to NFPA, floors should have a resistance falling between 25,000 and 1,000,000 ohms when measured between specified electrodes that are three feet apart. The upper limit specified by NFPA provides a safety factor of more than 10, even under conditions of low humidity, if materials such as wool and plastics are prohibited.

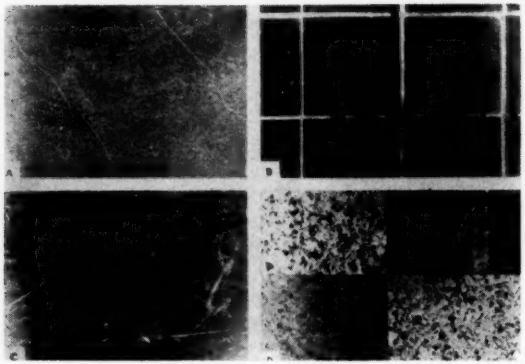
In the Bureau's laboratory investigation, however, electrodes were spaced at one-foot intervals —necessary because of the 18" x 18" sample size that was chosen for convenience in the experimental work. A preliminary study showed that this spacing would yield experimental results very close to those obtained from tests of an entire floor at an electrode spacing of three feet. Electrical tests were made under deliberately varied conditions of relative humidity and applied voltage. In addition to the laboratory tests on samples of flooring, field tests were made on five different types of conductive floors installed in hospitals in the Washington (D.C.) area.

RESULTS

Results from studies of the influence of moisture and other factors showed that conductive floors should give satisfactory service in hospital operating rooms if certain precautions are observed. If oxychloride floors are used, the humidity of the air in the room in which they are installed should be controlled, and the cleaning schedule for the floor should be carefully established and maintained. Laboratory tests indicate that otherwise the electrical resistance of the floor may fall outside the accepted limits.

The durability and appearance of at least two of the available materials (linoleum and rubber) may depend on periodic waxing. Conductive waxes containing carbon black which do not deposit an insulating film are available, and should be esthetically as well as electrically satis-





TOP: Experimental pedestrian traffic test ramp installed in corridor of office building to investigate performance of conductive flooring materials. RIGHT: Four samples from the test ramp: A (oxychloride) shows hairline cracks; B (ceramic) shows pitting in mortar joints; C (rubber) exhibits extreme scuffing and scratching; and D (vinyl) shows extreme soiling of light-colored tiles.

factory on these uniformly black floors. Sealers should probably not be used on conductive floors until proven satisfactory by extensive electrical tests.

ELECTROSTATIC TESTS

To substantiate the electrical test results, additional tests were carried out in which each type of floor was actually used to reunite electrostatic charges. Thus, a direct test was made of each flooring's effectiveness in eliminating static-electricity hazards.

There was excellent correlation between the electrical and electrostatic tests. For all but two of 12 specimens tested, peak voltage was less than 300 v when the resistance between two standard electrodes was less than 1,000,000 ohms. Conversely, the resistance was greater than 1,000,000 ohms when the voltage exceeded 300 v. Because this voltage is below the minimum sparking voltage in air, the specified 1,000,000-ohm limit with the standard electrodes was proven to be a reasonably valid criterion of the performance of these floors.

——NONELECTRICAL PROPERTIES STUDIED

The nonelectrical properties studied were indentation, scratch resistance, slipperiness, scrubbing, water absorption, and stain resistance. Results of each study showed that the characteristics of the conductive materials are comparable to those of the corresponding nonconductive materials.

Of the properties studied, scratch resistance is probably the most important in hospital operating-room floors for the sake of cleanliness as well as for ensuring good contact resistance. Two methods were used for measuring scratch resistance. In the first, a diamond point was moved across a flooring sample and the scratch width was measured. Loads on the diamond point were 250, 500, 750, and 1,000 grams.

In the second method, a pedestrian traffic test ramp was used to simulate actual flooring use. Photographs were made after 11 months (100,000 passages) and compared with photographs of unexposed flooring to determine the extent of scratching, smudging, and other damage.

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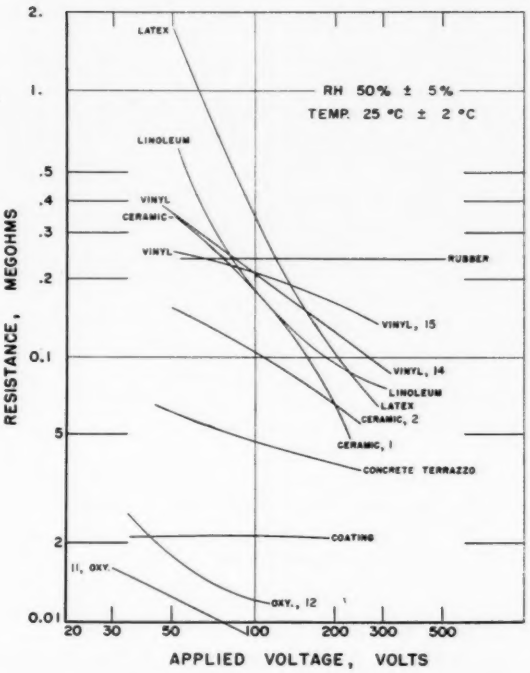
1. For further technical details, see "Conductive Flooring for Hospital Operating Rooms," by Thomas H. Boone, Francis L. Hermach, Edgar H. MacArthur, and Rita C. McAuliff, *J. Research NBS* 63C, No. 2 (1959).
2. "Hazards from Static Electricity," *NMS Tech. News Bul.* 36, 82 (June, 1952).
3. Code for Use of Flammable Anesthetics (Safe Practice for Operating Rooms), NFPA No. 56, National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.



ABOVE: Graph shows the effect of applied voltage on the electrical resistance of a number of floor tile materials. Resistance is measured several seconds after a steady-state voltage is applied.

Peritoneal Dialysis: Technic and Applications*

By Morton H. Maxwell, M.D., Robert E. Rockney, M.D., Charles R. Kleeman, M.D., and Mary R. Twiss, R.N.**

Complications of earlier methods of peritoneal dialysis, such as peritonitis, overhydration, electrolyte abnormalities, leakage, and drainage difficulties have been eliminated by a new technic of intermittent dialysis utilizing commercially prepared electrolyte solutions, special catheters, and a "closed system" of infusion and drainage.

This method was mechanically successful in 76 instances. Conditions treated satisfactorily included acute renal failure, barbiturate poisoning, intractable edema, hepatic coma, hypercalcemia, and chronic uremia.

*Condensed from an article in the June 20, 1959 issue of the *Journal of the American Medical Association*, with the permission of the *Journal* and the authors.

**The authors are from the department of medicine, University of California at Los Angeles, and Wadsworth Hospital, VA Center.

Although less efficient than the artificial kidney on an hourly basis, peritoneal lavage is easier to use over extended periods of time.

Solutions: Although previous authors have advocated extemporaneous preparation of the lavage fluid from commercially available solutions, we have found this to be arduous and unsatisfactory. Many hospital pharmacies do not stock the necessary anhydrous magnesium and calcium chloride. The pH must be accurately adjusted and the sodium bicarbonate added separately, or precipitations of calcium salts may occur. Caramelization and discoloration of the dextrose-containing solution may take place during autoclaving, and adequate sterilization is seldom assured.

Solutions are now prepared commercially and

may be stocked in ordinary liter infusion flasks in the hospital pharmacy, together with special Y-type administration tubing and sterile catheters. A dialysis thus can be started within 30 minutes after the decision is made.

The dialysis solution is essentially an idealized potassium-free extracellular solution with enough dextrose added (1.5%) to increase the osmolality to 372 milliosmols (mOsm.) per liter, somewhat higher than the levels we have found in uremic patients. This prevents absorption of administered fluid from the abdomen and the overhydration frequently reported after earlier procedures.

Potassium is omitted because dialysis is often performed to corrert hyperkalemia. When it is used for barbiturate poisoning or in other situations in which there is a normal serum potassium level, potassium chloride can be added as a concentrate by hypodermic syringe to bring the concentration to 4 mEq. per liter.

Since crystalloids diffuse in both directions across the peritoneal membrane, any biochemical abnormalities in the patient's serum will be partially corrected by the use of a solution containing "normal" concentrations of all the physiologically important electrolytes. To alter the solutions according to the individual patient's specific electrolyte pattern is hazardous in most hands and contributes little to the over-all clinical results.

Since 2 liters of solution are given simultaneously, with immediate mixing within the peritoneal cavity, additional drugs or electrolytes need only be inserted into one of the bottles, lessening the chance of bacterial contamination.

To each 2 liters of solution are added 25 mg. of tetracycline, 8 mEq. of potassium chloride (if the serum potassium level is not elevated), and 10 mg. of aqueous heparin. The use of heparin is discontinued after three exchanges if the outflow fluid is not grossly sanguineous.

When a peritoneal dialysis is performed for the relief of intractable edema, a hypertonic solution with identical concentrations of electrolytes but with 7% dextrose (versus 1.5%) is used, having an osmolality of 661 mOsm. per liter. This results in marked negative fluid balance during the procedure. Ten percent dextrose (842 mOsm. per liter) has also been used for this purpose.

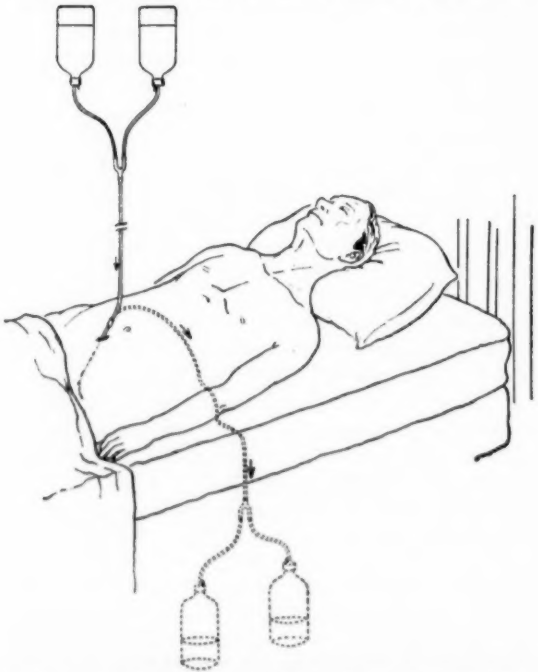
Materials: The necessary equipment (fig. 1) consists of an ordinary paracentesis set with a straight 17 F. Duke trocar set, suitable quantities of dialysis solution with tubing, and sterile catheters. After experimenting with plastic catheters of various types, it was found that the most suitable is a fairly rigid nylon catheter, 11 in. long, slightly curved at the distal end, with a solid, rounded tip. The distal 3 in. is perforated with multiple smooth holes of very small diameter (80

perforations, 0.02 in. in diameter). The external diameter of the catheter is 0.136 in. and is made to fit snugly into a 17 F. metal trocar.

Perhaps the single greatest complication in the past has been difficulty in obtaining adequate outflow. This led various workers to utilize inflow and outflow tubes through two separate abdominal incisions, to devise elaborate sump pumps for negative-pressure drainage, and to insert the tubes under direct vision in the operating room. In retrospect, inadequate drainage resulted from (a) clinging of the omentum and intestines around the irritating metal and rubber tubes, (b) fibrin clots within the outflow tube, and (c) most important, plugging of the tube with tiny bits of omental fat sucked into the lumen through the perforations. The use of nonirritating plastic catheters and the addition of adequate heparin to the inflow solution has eliminated the first two factors. The simple expedient of greatly reducing the diameter but increasing the number of the multiple distal perforations has successfully prevented particles of omentum from entering the catheter and permitted the use of simple, smooth catheters rather than more costly double-lumened or grooved tubes.

Procedure: The patient should be supine or semi-supine with his bladder emptied just prior to the procedure. No special sedation is necessary unless the patient is unduly apprehensive or agi-

Figure 1. Peritoneal dialysis procedures (see text for details)



tated. The abdomen is shaved, prepared, and draped as for a pararotomy. After local infiltration with procaine hydrochloride, an incision is made in the midline about one-third of the way from the umbilicus to the pubic bone. The incision should be small enough so that the skin fits very snugly around the trocar. The scalpel blade (no. 11 Bard-Parker) is inserted into the anterior abdominal wall until it is felt to "grate" on the linea alba, and a small incision is made in the latter. The midline is relatively avascular, and any slight superficial bleeding which occurs is usually controlled by lateral pressure exerted by the trocar and catheter.

The trocar, with the stylet in place, is inserted through the incision into the peritoneal cavity.. At times, a sharp thrust is necessary, and the patient may experience some pain as the peritoneum is stretched. When the peritoneum has been pierced, with the stylet removed the trocar should easily slide in to its full length, so that only the proximal hub protrudes above the skin. In very thin individuals, we have occasionally distended the abdominal cavity with 2 liters of dialysis solution infused through a large-bore (no. 15) hypodermic needle before attempting insertion of the trocar.

The plastic catheter is then fitted through the trocar. The permanent curve at the end of the catheter and its relative rigidity permit it to be manipulated by rotation from the proximal end, much as is done during cardiac catheterization. It also prevents kinking or floating of the catheter to the surface within the abdomen. The rounded tip minimizes injury to the abdominal contents. The direction of the catheter can also be altered by angling the entire trocar in any direction. The catheter is aimed dorsally and toward the left or right lumbar paravertebral sulcus. It is at times necessary to rotate it in various directions, trying to insert it each time, before omentum is pushed aside or a natural pathway is found. Ideally, the catheter should extend well into the peritoneal cavity. On a few occasions, when complete insertion seemed impeded (by adherent omentum), 1 or 2 liters of solution was allowed to run in and the catheter was subsequently readjusted.

The trocar is then withdrawn and the catheter connected to the Y-tubing, which has been previously connected to 2 liters of dialysis solution warmed to body temperature. Necessary drugs (tetracycline, heparin, etc.) are added in advance. The solution is permitted to flow into the abdominal cavity by gravity as rapidly as possible, ordinarily taking between 5 and 10 minutes for completion. If the fluid flows in more slowly than this, the catheter should be repositioned, as its tip may be buried in omentum.

When the bottles are empty but the tubing is still filled with fluid, the tubing is clamped and the bottles are placed on the floor beside the patient's bed. The fluid is permitted to remain within the abdominal cavity for one hour, after which the clamp is removed and the abdomen is drained by a siphon effect through the closed system back into the original two bottles. If the system is patent, gravity drainage should occur rapidly and steady forceful streams of fluid should be seen entering each of the bottles. When the flow slows down and becomes a steady drip, manual compression of the abdomen toward the catheter may cause resumption of steady flow for a short while. Drainage should take no more than 10 minutes. Since the liter flasks are graduated in both directions, precise fluid balance can be ascertained at a glance.

Just before drainage is begun, 2 liters more of solution with fresh tubing are prepared, so that as soon as drainage ceases a new infusion can be started. This is repeated continuously for from 12 to 36 hours, depending on the purpose of the dialysis and the number of exchanges desired. Usually between 30 and 50 liters is exchanged. A careful protocol is kept, listing exact time for starting and ending each exchange, drugs added, vital signs, and fluid balance. Ideally, after the first few exchanges intermittent peritoneal dialysis can become a nursing procedure, with the physician called only if there is difficulty with fluid balance or any untoward complication.

The most frequent complication of peritoneal dialysis reported in the literature has been peritonitis. In our experience, clinical peritonitis has never occurred, and 43 cultures of peritoneal fluid sampled at the end of dialysis have all been sterile. Furthermore, in 16 autopsies performed on patients who had undergone one or more peritoneal dialyses in the month prior to death, there was no evidence of peritoneal irritation or bleeding, except for local hematomas of the mesentery in one patient who had a uremic bleeding tendency. The threat of peritonitis has been eliminated by (a) the use of an essentially closed technic with the dialysis fluid drained into the original bottles, (b) the use of new sterile tubing with each infusion, (c) the addition of a broad-spectrum antibiotic to the solution, and (d) limitation of the procedure to a maximum of 36 hours.

Complications: Sometimes abdominal pain is encountered, particularly toward the end of the outflow period. It is invariably ameliorated by instillation of the next inflow fluid, but, if the pain is severe, it can be treated with 5 cc. of 2% procaine hydrochloride instilled through the catheter into the peritoneal cavity. Restlessness and/or pain may require injections of meperidine

(Demerol) or a short-acting barbiturate. Blood-tinged fluid is not uncommon during the first few exchanges and is caused by subcutaneous bleeding incident to the incision; if it persists, a purse-string suture pulling the adjacent skin and tissues around the catheter shaft may help. Severe bleeding has never occurred in our series.

Omentum or intestine which is adherent to the anterior abdominal wall or adhesions from previous abdominal surgery may prevent catheter insertion or result in poor drainage from loculated cavities. We were unable to perform dialysis in six patients, five of whom had widespread adhesions. In one patient who was extremely obese and in two patients with previous abdominal surgery and adhesions, the catheter was successfully inserted in the McBurney area on the right or in the corresponding point on the left side without difficulty.

At times, leakage around the catheter occurs. As with subcutaneous bleeding, a purse-string suture halts this complication. The original incision is intentionally made as small as possible to prevent leakage. It is preferable not to suture the catheter to the skin, so as to be able to manipulate it if necessary.

If the outflow stream slows down or stops, slight twisting or remanipulation of the catheter tip sometimes restores adequate flow. If this maneuver fails, 20 cc. of saline solution can be forced through the catheter under pressure from a syringe in an attempt to clear fibrin clot. Should this be unsuccessful, the catheter should be withdrawn and inspected; if obstructed by clot, it can be replaced with a fresh catheter along the original path. For this purpose, it is well to have a second sterile trocar available. If drainage is rapid but incomplete because of absorption of fluid, the solution may be made more hypertonic by the addition of from 50 to 200 cc. of 50% dextrose to each 2 liters until the desired negative balance is achieved. If this is necessary for more than a few exchanges, it is preferable to use 1 liter of 1.5% dextrose and 1 liter of 7% dextrose solution for each exchange, since the addition of dextrose in water to the stock solution dilutes the electrolytes accordingly.

Abdominal distention and/or ileus has not been prominent, and, in the few cases in which it occurred, has disappeared within 24 hours after the procedure. Local edema of the anterior abdominal wall may be encountered if the catheter is not inserted far enough so that all of the perforations are within the peritoneal cavity. In a very thin person, or when the proximal end of the catheter extends more than 2 or 3 in. above the skin surface, part of the protruding end may be cut off with a sterile scissors.

When very hypertonic (7 to 10% dextrose) dialysis solution is being used to achieve negative

fluid balance, there may be a sudden decrease in blood pressure. This is caused by temporary hypovolemia from the rapid movement of fluid from the vascular compartment into the peritoneal cavity; there is a lag in the replacement of this plasma volume from the interstitial tissues. If this occurs, loss of fluid can be slowed down by using a solution with less dextrose (and less osmotic pressure). The immediate treatment is restoration of vascular volume by the infusion of salt-poor human albumin or whole blood. When using hyperosmotic solutions, we have adopted the practice of diluting 25 Gm. of albumin in 500 cc. of 5% dextrose in water and infusing this at a slow rate throughout the dialysis. Hypotension can then be corrected as necessary by increasing the rate of infusion.

Contraindications: Infection of the peritoneal cavity is an absolute contraindication to peritoneal dialysis. Recent or extensive abdominal surgery is a relative contraindication, although we have successfully dialyzed three patients after cholecystectomy, abdominal aortic resection, and appendectomy, five, eight and six days after surgery respectively.

Cardiac Arrest: Blanket Diagnosis Too Often Used?

A special symposium on operating-room fatalities was presented during the 1960 convention of the American Medical Association in Miami Beach in June. Speakers were a surgeon, an obstetrician-gynecologist, an anesthesiologist, and a pathologist.

Cardiac arrest is a major cause of operating-room deaths. The increased incidence is due not only to a more acute awareness of the problem and better diagnostic measures than those employed 30 years ago, but also to the increasing incidence of surgery on elderly patients. In patients over 80, for example, death from cardiac arrest is 20 times higher than in patients under 30.

Serious illnesses in surgical patients also contribute to the high incidence of cardiac arrest: the death rate in such patients is 30 times higher than in good-risk patients.

Recovery rates are improving. In the last five years, the recovery rate has reached 50 percent, whereas in the preceding 10 years only 37 percent of patients recovered from cardiac arrest.—*Henry K. Beecher, M.D.,* Boston.

* * *

The surgeon has a long way to go to achieve optimum performance in his own operating room. Surgeons insist on good anesthesia, but at the same time they must carefully review their own positions and those of their resident staffs, interns, and others. From time to time, all deaths in the operating room and emergency room should be impartially analyzed to determine contributing factors.—*Curtis P. Artz, M.D.,* Jackson, Miss.

* * *

Cardiac arrest is as much of a problem in obstetrical patients as in surgical patients. But more deaths occur in obstetrical patients from aspiration of food.

Many drugs used in obstetrics increase the emptying time of the stomach; obstetricians have become careless about warning patients against eating if the onset of labor is suspected. Many delivery suites are not equipped with tip tables to help in emptying a patient's stomach.

The shortage of competent anesthesiologists in this field is also a contributing factor.—*James H. Ferguson, M.D.,* Miami, Fla.

• • •

Deaths in the operating and delivery rooms are too often attributed to "cardiac arrest." The term is being used to designate a death in the operating room, whether or not the real cause is known. It is wrong to lump all deaths under this one diagnosis.

Because the medical profession has become accustomed to its use as a blanket diagnosis, it is too late to try to redefine cardiac arrest or to restrict use of the term; so perhaps it should be eliminated entirely from the medical vocabulary.

Diagnostic ability should be put to work to determine the cause of every death – to pinpoint what actually happened in each case. There must be some pathological or physiological basis for a situation severe enough to be incompatible with life.

When the cause of death is not obvious, autopsy is indicated. It may reveal a cause of death 100 percent unsuspected, and remove the onus of blame from the surgeon or anesthesiologist. For instance, after the death of a healthy 19-year-old girl during delivery, autopsy revealed a massive pulmonary embolus. She had had no previous symptoms.

Anesthesia fatalities are usually caused by overdose of drugs, too rapid administration of drugs, or asphyxia from an occluded airway or poor ventilation.

Surgeons' responsibilities for fatalities lie in their inadequate preparation of patients, poor treatment of hemorrhage, excessive trauma during surgery, or injudicious surgery on the acutely ill patient.

The treatment of cardiac arrest is cardiac massage. While every clinician should proceed with the standard treatment of cardiac arrest, he should realize that it is very unlikely that a severely ill patient will be restored to health. On the other hand, the patient who was in good physical condition initially has an excellent chance of recovery.

Many anesthesiologists recall instances in which the patient's vital signs have disappeared. In the few minutes of decision-making, the anesthesiologist vigorously squeezes the breathing bag, and the patient's pulse often returns. This suggests that positive-pressure artificial respiration may be very important in resuscitating these patients. There is

little doubt that cardiac massage without artificial respiration is relatively worthless, and thoracotomy without artificial respiration may be more harmful than helpful. The patient with cardiac arrest should probably be treated first with positive-pressure artificial respiration and then cardiac massage.

More important, however, is the effort to reduce the incidence of cardiac arrest by careful preoperative preparation of the patient, adequate blood-volume replacement, and good respiratory ventilation.—*Jay Jacoby, M.D.,* Milwaukee, Wis.

Discussion

Q. What proportion of the three minutes allowed for resuscitation of the patient in cardiac arrest should be allotted for positive-pressure administration of oxygen?

DR. JACOBY: At this time, I do not believe that any time should be spent exclusively on administration of oxygen. It should be given while the incision is being made and continued throughout the thoracotomy.

Q. Should oxygen be administered through an endotracheal tube or through natural air passages?

DR. JACOBY: There is nothing magic about an endotracheal tube. If the anesthetist knows the patient is ventilating well, he should not waste time putting in a tube. He can usually tell by squeezing on the bag whether the lungs are inflating well. If the lungs will not inflate, then a tube should be put in.

DR. BEECHER: Anybody skilled in anesthesia should be a good bronchoscopist. Any anesthesiologist should be obliged to become a bronchoscopist.

DR. JACOBY: Most anesthesia is administered by people who are not as experienced as the anesthesiologists in university centers. Many anesthetists do not know how to intubate, much less bronchoscope a patient. If the person is unskilled, inflating the lungs without the use of an endotracheal tube is much better for the patient.

An Effective Cardiac Resuscitation Program

By L. Brent Goates*

A case or two of cardiac arrest – a rather rare but continuing threat to all surgery – inspired a noteworthy educational program among surgeons and operating-room nurses at the Latter-Day Saints Hospital, Salt Lake City, Utah.

Medical staff members, not satisfied with the outcome of these few cases of arrest, were determined to improve their methods of coping with this type of emergency. The president of the medical staff appointed a committee to study the problem and make recommendations.

After a number of meetings, this special committee, headed by W. Ray Rumel, M.D., thoracic surgeon, and including a cardiac research physiologist, an anesthesiologist, and a general surgeon, developed the "Cardiac Resuscitation Chart."

Five hundred copies of the chart were printed, and some were distributed to selected hospitals. Doctors at these hospitals "spread the word" about the chart to physicians at other hospitals. As a result, many requests for copies were received from physicians and hospitals throughout the country, and the supply was exhausted.

Several important changes have been made in the chart by the cardiac resuscitation committee, and a second printing was completed.

[The revised version is reproduced on pages 104 and 105.]

In the Latter-Day Saints Hospital, the chart is framed and hung over the scrub sinks, so that surgeons can see it while they are scrubbing up. Copies

*Mr. Goates is assistant administrator, Latter-Day Saints Hospital, Salt Lake City, Utah.

are also displayed in the surgeons' locker room and in the doctors' lounge.

The chart was just the beginning project for the committee, which sees its mission as a continuing educational program among surgeons and nurses – all of whom might at any moment find themselves in a situation in which their anesthetized patient's life is in jeopardy because of cardiac arrest – and only four minutes remain in which to alter the fatal course. The economy of time and the pursuit of correct action in this crisis most often determine whether the patient will survive.

The need for immediate action argues for complete staff preparation in advance of the emergency. Surgeon and anesthesiologist should be prepared, so that they can proceed immediately while the chest surgeon is being sent for. Chest surgeons and others best prepared logically take the lead in encouraging all staff members to learn how to meet the situation promptly.

As a second project the committee arranged for a practical practice experience for physicians to master the technic of cardiac massage. A unique and clever display was created by Dr. Rumel and his associates, using a fresh pig's heart hooked to a calibrated tube of red-colored fluid (colored water is used and a thickening substance is added). The tube registers the squeeze pressure of each contraction by the participating physician.

The exhibit gave some 250 physicians at the annual meeting of the Utah State Medical Association last fall an opportunity to squeeze the heart under conditions almost identical to those in human beings undergoing cardiac arrest.

With each doctor practicing for five to six minutes, five pigs' hearts were worn out in three days, and the exhibit "stole the show" at the meeting.

Each physician attempting the exercise donned white cotton gloves, which are now standard sterile equipment in the cardiac arrest tray maintained in surgery at the hospital. The advantage of cotton gloves over the conventional rubber gloves is that they prevent the heart from slipping out of the hands of the surgeon, but still permit the doctor to maintain the "feel" of the organ – an aspect which is just as important as the pressure applied.

It has been demonstrated that the physician massaging the heart has to reach a certain minimum pressure to provide sufficient pulsation to circulate the blood. An interesting finding at the convention was that many physicians had some difficulty reaching this pressure and therefore would not have been effective in dealing with cardiac arrest in a human being. Many had never felt a live heart before, and thus didn't know just what was required of them.

The Acute Emergency Is Now Over Since: 1. The lungs are being ventilated with oxygen and 2. The circulation to the brain is being provided manually

CALL FOR CONSULTATION

Caution — Defibrillating currents are dangerous to personnel!!

THIRD

RESTORE HEART BEAT

A. Cardiac Standstill or Asystole (Majority of cases).

1. Continue compression. Adequate heartbeat usually returns within a minute or two as myocardial tone and color improve.
2. If beat fails to return, open pericardium parallel to phrenic nerve from diaphragm to base of heart.
3. If myocardium is atonic and flabby inject 3 cc. of 1 to 10,000 adrenalin into either ventricular chamber. (Repeat if necessary, 3 to 5 minutes later.)
4. Continue compression with either or both hands.
5. If myocardium is tense, contracted and unable to fill, inject prostigmine (neostigmine) 5 cc. 1:20,000 into either ventricle. Continue compression. (Repeat if necessary, 3 to 5 minutes later.)

DON'T use any drugs except for specific reasons.

DON'T use electric shock.

DON'T contuse myocardium.

DON'T displace heart excessively.

DON'T distort base of ventricles.

B. Ventricular Fibrillation (Minority of cases initially).

May follow standstill.

1. Call for cardiac surgeon.
2. Compress heart until conditions are favorable for defibrillation:
   a. Myocardium pink for 1 minute.
   b. Myocardial tone good.
   c. Fibrillatory movements fine and rapid.
   If necessary inject 3 cc. 1 to 10,000 adrenalin into either ventricle and continue to compress.
3. Defibrillate when conditions are favorable.
   a. Select appropriate voltage (approximate).
      Small electrodes — plus or minus 100 volts
      Medium electrodes — plus or minus 150 volts
      Large electrodes — plus or minus 200 volts
   b. Select appropriate electrodes—small medium or large—depending on heart size.
   c. Apply electrodes firmly to contact all of ventricular surface.
   d. Shock three times at intervals of 1 second and duration of about .2 second.
   e. If defibrillation is successful, normal heart beat should return in 2 or 3 seconds. Then avoid all possible myocardial stimulation.
4. If unsuccessful, resume compression and repeat shock after favorable conditions have been re-established. (See 2 a, b, c.)
5. After cardiac resuscitation, support cardiovascular system with cautious use of intravenous fluids, blood, vasopressors, atropine, digitalis, etc., as specifically indicated.
6. Routine repair and closure with water seal drainage.

DON'T apply electric shock until conditions are favorable.

DON'T inject:

Potassium

Procaine

Pronestyl

Calcium chloride

Other drugs

(Unless clearly indicated after consultation)

CARDIAC RESUSCITATION

PROGRAM OF ACTION

W. R. Rumel, M.D., Chairman
Paul D. Keller, M.D.
Scott M. Smith, M.D.
Homer R. Warner, M.D.

Recommended by The Committee on Cardiac Resuscitation
Latter-day Saints Hospital, Salt Lake City, Utah

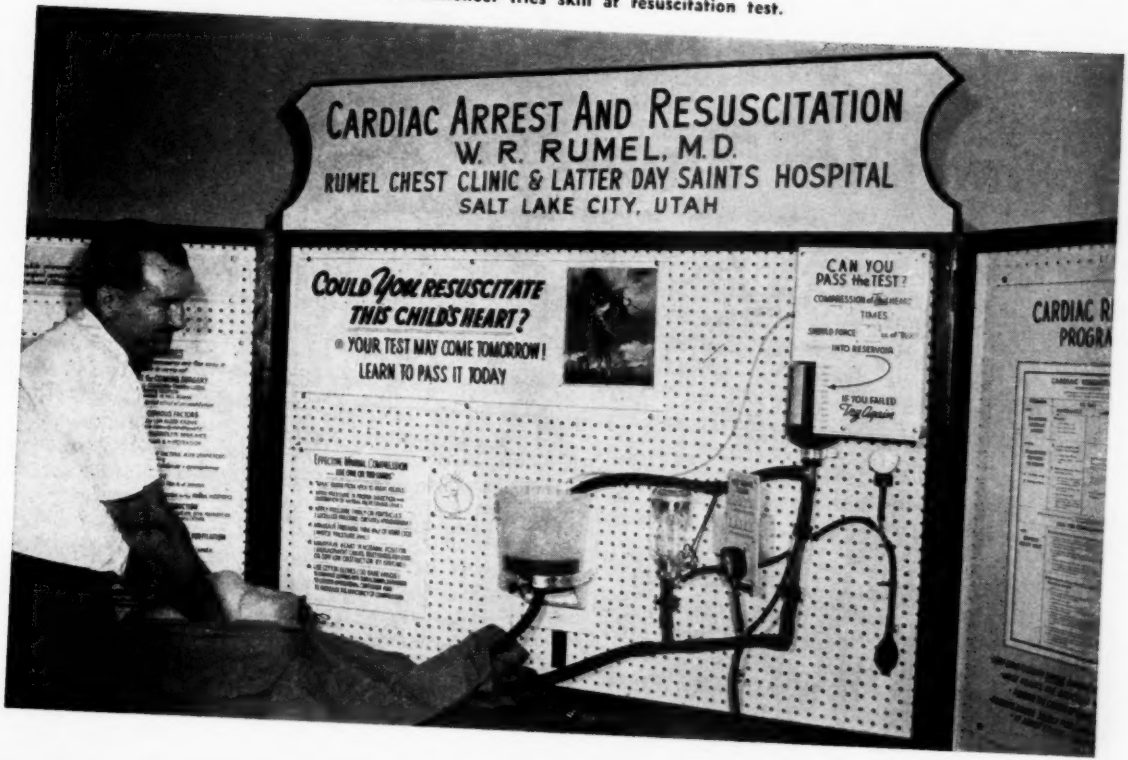
May, 1958
REVISED FEBRUARY, 1960

PROBLEM	DO THIS		AVOID THIS
	IMMEDIATELY	**LATER**	
FIRST **DIAGNOSE CARDIAC ARREST**	**Recognize:** Absent Carotid Pulse Absent Heart Sounds Absent Blood Pressure		**DON'T** squander the four minutes you have to restore function. **DON'T** feel for pulse in small peripheral arteries. **DON'T** prolong search for blood pressure or heart sounds. **DON'T** use ECG.
SECOND **TRANSPORT OXYGEN TO BRAIN** **A. Ventilate Lungs** **B. Massage Heart**	**A. Ventilate Lungs — Positive pressure** 1. 100% oxygen-mask with bag. 2. Mouth-to-mouth breathing (if oxygen is unavailable) 3. Provide and maintain clear airway. **B. Restore Circulation by Manual Compression of Heart (Massage)** 1. Open left chest between ribs from sternum to midaxilla just below nipple or breast. 2. Cut adjacent cartilages lateral to sternum. 3. Spread ribs manually. 4. Compress heart in hands or against chest wall at normal rate or as indicated by good ventricular filling.	Call Anesthesiologist. Insert endotracheal tube when feasible. Establish intravenous drip Time and chart medications and events. Insert rib spreader as soon as convenient.	**DON'T** inject medications through chest wall. **DON'T** prep skin. **DON'T** wait for gloves. **DON'T** count ribs. **DON'T** wait for rib spreader.

CARDIAC RESUSCITATION *
PROGRAM of Action
TREATMENT
OF
CARDIAC ARREST
MUST BE PRE-PLANNED SWIFT AND EFFICIENT !
CEREBRAL CIRCULATION MUST BE RESTORED WITHIN 4 MINUTES! THIS ALLOWS NO TIME FOR STUDY OR EXPERIMENTATION.
DELAY IS RESPONSIBLE FOR 85% OF FAILURES!
MAKE PLANS TO SUCCEED
1. BEGIN YOUR ORGANIZED PLANNING TODAY
2. REHEARSE YOUR PLAN EACH TIME YOU SCRUB
3. PRACTICE CARDIAC COMPRESSION AT REGULAR INTERVALS
* MAY BE OBTAINED FROM LATTER DAY SAINTS HOSPITAL SALT LAKE CITY, UTAH

The exhibit has been shown at other state medical association conventions and at the annual meeting of the American College of Chest Physicians. In between such appearances the exhibit is installed as a permanent display in the hospital's cardiovascular research area, where constant educational value may be derived by members of the hospital's medical staff.

Conventioneer tries skill at resuscitation test.


CARDIAC ARREST AND RESUSCITATION
W. R. RUMEL, M.D.
RUMEL CHEST CLINIC & LATTER DAY SAINTS HOSPITAL
SALT LAKE CITY, UTAH
COULD YOU RESUSCITATE THIS CHILD'S HEART?
YOUR TEST MAY COME TOMORROW!
LEARN TO PASS IT TODAY
CAN YOU PASS the TEST?
IF YOU FAILED Try Again
CARDIAC R
PROGRA

Heart Surgery Technics, Cardiac Arrest Prevention Discussed in ACS Courses

The postgraduate courses in surgery are popular features of the annual clinical congress of the American College of Surgeons. In the following report, TOPICS' *nurse consultant, Dorothy W. Errera, R. N., presents abstracts of selected lectures from the postgraduate courses at the 1960 congress, held in San Francisco October 10-14.*

Describes Technic for Long-Term Use of Artificial Pacemaker

A technic of heart pacing employing an electrode in a conventional intracardiac catheter has been used in 23 patients, ranging in age from 48 to 81 years. Twenty-one of the patients had atrioventricular dissociation with Stokes-Adams seizures. One patient, paced in May, 1959, still wears the apparatus. The first case, treated in August, 1958, was a 76-year-old patient who is alive today and no longer needs the indwelling apparatus.

The fact that no anesthesia is needed with this technic is a distinct advantage. The catheter with the electrode in place is passed through the jugular and down into the lower right chamber of the heart. The procedure is done under fluoroscopic control so that placement is accurate. A second indifferent electrode is implanted in the skin of the chest.

Initially, electrodes were monofilament wire, which often broke inside the insulation. Braided wire has eliminated this nuisance. The tip of the electrode still does not rest as securely as desired, and breaks in insulation are always possible.

It is important that no apparatus connected to wall current ever contact these wires. Three deaths

have occurred in patients who developed ventricular fibrillation from leakage of current from wall outlets.

To date there have been no hearts that did not respond to the technic. One disadvantage, however, is the risk of infection accompanying the break in the integument. Six patients did develop bacteremia, which was controlled with antibiotics and replacement of the catheter in use with a clean one. The problem of clotting around the individual electrode is obviated with long-term administration of anticoagulants.

Another method of pacing, utilizing the external pacemaker, may be useful temporarily, but shocks the internal chest wall, and the ulcers and burns that develop under the electrodes are painful for the patient. In patients with heart block produced in surgery, a direct wire has been planted in the myocardium. After two weeks, however, the heart becomes more refractory.

A battery impulse generator implanted on the skin with a radio frequency transmitter shows great promise, but clinical experience is limited to date. When the ultimate instrument is developed, it is important that it be equipped with a moderator, so that when the heart takes over on its own, it will not have to compete with the artifical pacemaker.—*Elliott S. Hurwitt, M.D.*, chief, surgical division, Montefiore Hospital, New York City.

Performing Cardiac Surgery with Use Of Hypothermia and Pump-Oxygenator

In cardiac surgery utilizing profound hypothermia with the pump-oxygenator, it is not necessary to wait for a low level of hypothermia before starting the operation. The incision can be made while the patient is still cooling. Once the cooling is finished, the perfusion is continued.

Cooling is always started on a partial bypass. Temperatures in the mid-esophagus, the rectum, and the water in the heat-exchanger are monitored. Moderate flow rates are used: 25-30 cc./minute/kg. for adults; 24-60 cc./minute/kg. for infants and children. The inflowing arterial blood temperature is kept one degree above the esophageal plateau, because the central nervous system is the greatest concern, and at this temperature the blood will continue to warm the brain and spinal cord.

Brain temperature will depend on how rapidly the esophagus is cooled and the length of time of perfusion. The brain temperature follows that of the esophagus closely in the upper ranges but cannot be assumed to be the same in deep hypothermia.

Rewarming is accomplished as carefully as cooling, to avoid brain damage. It is started gently. The inflowing arterial blood is raised to 32° C. This temperature is maintained until the heart has

a regular beat. Then the patient returns to a partial bypass. Warming is discontinued when the rectal temperature is above 30° and the esophagus temperature above 30-34° C.

Using a minimum of equipment and blood increases the patient's chances of survival. Efficient heat-exchangers make it possible to apply principles of safe cooling.—*Ivan W. Brown, Jr., M. D.*, associate professor of surgery, Duke University School of Medicine, Durham, N. C.

Better Training Raises Resuscitation Rate in Cardiac Arrest Cases

The current rate of cardiac arrest, countrywide, is about one in every one or two thousand cases. A resuscitation rate of 20 to 30 percent is usual. The incidence of cardiac arrest has not decreased at the Los Angeles County Hospital, but 70 percent of patients in arrest have been resuscitated in the last six years.

Our increased effectiveness in treatment is believed to be the direct result of a training course which is available to all physicians in the area.* Any physician can resuscitate a patient in arrest, but he needs some confidence to manage the problem. He need not be a thoracic surgeon, but he does need some practical experience in dealing with the situation.

In making a diagnosis, one should suspect arrest if there is a sudden disappearance of pulse and blood pressure, and continue to suspect it until some other diagnosis can be proved. Palpation of a major artery—such as the femoral, which is always available—can be relied upon to confirm the diagnosis. If there is no pulsation, treatment for arrest is begun.

It should not be thought that there is a grace period of three minutes, because some time may have elapsed before failure was noted. There is a distinct relationship between the time wasted and the salvage rate. Ninety to 95 percent of patients will be lost if three minutes are wasted.

Three or four firm blows on the precordium will occasionally start the heart beating. If this maneuver is to be effective at all, it will be immediately so. If it is unsuccessful, the closed-chest method of resuscitation should be tried for 15 seconds.

The closed method, which has been successful in the hands of some investigators, is obviously preferable to the open method. The sternum is depressed with both hands. The patient must be

*This course is described by Dr. Mikkelsen in the article, "Cardiac Arrest and Resuscitation," which appeared in the June, 1957, issue of HOSPITAL TOPICS, pp. 96-99.

on a firm surface. As one presses down, the sternum compresses the heart against the backbone, and circulation should be inspired.

If pulse rate and color improve during the 15-second trial of this method, all is well. Otherwise, thoracotomy is indicated.

Because there will be no bleeding in a patient in arrest, and cosmetic result is unimportant, a bold incision is made in the left chest beneath the area from the border of the sternum to the mid-axillary line. The interspace used is unimportant, but the technic of massage is very important, because a systolic blood pressure of 100, once attained and maintained, will keep a patient alive for a long time.

Most patients in cardiac arrest are in ventricular standstill and can be resuscitated in 20 to 30 seconds of massage. Good function should be obvious in less than one minute of massage. If after this time there is no response, use of epinephrine and calcium chloride may be indicated. They should be injected directly into the heart, so that they will be distributed to the coronary circulation as the heart is massaged. Epinephrine is more potent but is quite likely to convert the heart to standstill.

An electric defibrillator using the shortest time interval available, 1/10 to 1/20 of a second, with the maximum output, 160-280 volts, is helpful. If defibrillation is still difficult, one percent procaine may be tried.

Once the heart is started, cerebral resuscitation may be a problem. If additional anesthesia is not necessary as the chest is closed, it can be suspected that the patient will remain in coma, and hypothermia, down to 28-30° C., must be started immediately. Cooling must be achieved in seven hours to be successful. Thorazine in large doses is necessary to control the patient's shivering, or else he maintains his body temperature.

The patient is kept at 28-30° C. for 12 to 24 hours. In this time, it is impossible to evaluate his mental status. He is then allowed to drift up to 34° for evaluation. If he shows signs of awakening, he is allowed to drift to 36°, and then, if he is still awake, allowed to come up to normal temperature. If he is still comatose at 34°, he is taken back down to 28-30° for another 24 hours. — *William P. Mikkelsen, M.D.,* Los Angeles.

Problems of Heart Transplantation: Impossible to Transplant Both Lungs

The technic of heart transplantation is purely experimental. The problem is to maintain the heart while it is out of the body and to have it maintained in the recipient animal. If one can prevent the development of small clots in the

capillary system, one can maintain the heart at room temperature for at least 90 minutes.

If the heart is refrigerated at 4° in nutrient solution, it can be maintained up to six or eight hours with excellent function and tone; up to 24 hours with some function, and up to 36 hours with minimal function. This means there are about eight hours available in which the procedure can be done.

Including both lungs in the transplant with the heart facilitates the technic. It is done in such a way that at no time is the heart's function totally interrupted. This should work well, but unfortunately it doesn't. All the animals eventually die of respiratory causes. It is apparently physiologically impossible to transplant both lungs.

Transplanting with one lung involves many more anastomoses, but the animal is able to breathe and survives longer periods of time. Stainless steel couplers are used to hasten anastomoses of veins. The right lung is the easier of the two to transplant because of its connections. The heart, once removed, is infused through the atrium with lactated Ringer's solution at room temperature to remove all blood from the capillary circulation.

To date, transplants have been to the dog's neck, with anastomosis to the proximal carotid artery. The pericardium is maintained over the heart at all times during the procedure. Tiny amounts of calcium chloride and adrenalin may be used to restore the heart beat.

The not-too-distant future may see great developments in the technic and survival times.—*Watts R. Webb, M.D.*, assistant professor of surgery, University of Mississippi School of Medicine, Jackson.

Lists Causes of Cardiac Arrest, Recommended Steps in Prevention

Cardiac arrest occurs characteristically in healthy patients scheduled for surgery unrelated to the heart. There are several possible causes: a disturbance of the vaso-vagal reflex, as during intubation and extubation; a change in blood pH, or anoxia, which is sometimes due to such a simple cause as forgetting to change the carbon dioxide absorber on the anesthesia machine. Cardiac arrest may also follow massive blood loss.

Preoperative administration of atropine and an operating team alert to the patient's condition during intubation and extubation are essential for the prevention of cardiac arrest. A clear airway and good oxygenation are obvious necessities. A dose of calcium gluconate after every two transfusions of ACD blood when multiple transfusions are in order will minimize the risk of arrest from this source. Repeated infusions of cold blood may make the heart hyperirritable and induce arrest.

An esophageal stethoscope, fitted with ear plugs, is incased in a condom attached to a catheter. This is passed in all patients having general anesthesia, and the anesthetist listens continuously to the heart beat.

The professional staff of any hospital should be prepared (by animal demonstration and practice) to treat cardiac arrest. In addition, fully equipped emergency carts should be ubiquitous throughout a hospital.—*Ben Eiseman, M.D.*, associate professor of surgery, University of Colorado School of Medicine, Denver.

Preventing Thrombophlebitis In the Postoperative Patient

Ambulation to nurses often means getting a patient out of bed to sit in a chair and then lifting him back to bed. The patient must get up and walk if ambulation is to have any significance in preventing thrombophlebitis. He should either be up walking or flat in bed with his legs elevated. Conservative measures of heat and elevation are important in the treatment of thrombophlebitis.

Ace bandages are not used unless applied by the physician. Too often, when applied by an unskilled person, the Ace bandage acts as a tourniquet.

Anticoagulants are important and are started four hours postoperatively. Fibrinolytic agents are ideal, but proper dosage is essential. A priming dose may be about 100,000 to 200,000 units. This is repeated every two or three hours for at least 36 hours. The expense of therapy is impressive; 50,000 units cost about $50.

When the prothrombin is down 40 percent, dosage is eased off. Because the original factors producing the clot may still be present, the patient is continued on anticoagulants when the fibrinolytic agent is stopped.—*Frank H. Leeds, M.D.*, assistant clinical professor of surgery, University of California School of Medicine, San Francisco.

New Heart-Lung Apparatus Developed

The problem of obtaining large quantities of freshly-drawn blood needed for use with a heart-lung machine has been alleviated considerably by the heart-lung apparatus recently perfected at Children's Hospital, Boston.

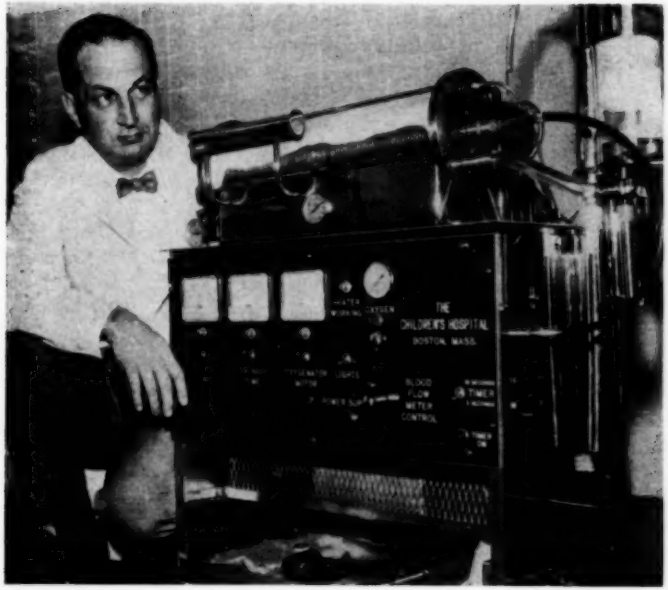
The heart-lung machines presently in use in many hospitals must be primed with from one to four pints of freshly drawn blood. Up to 30 additional pints may be needed for transfusions and as a reserve. The blood must be matched to the patient's blood group, and drawn not earlier than the day before the operation. Stored blood cannot be used.

Robert E. Gross, M.D., surgeon-in-chief at Children's Hospital and Ladd professor of children's surgery at Harvard Medical School, reports that the apparatus perfected at the hospital damages the blood so little that the four pints needed as primer can be used for two successive patients. Blood remaining in the machine after a single operation can be withdrawn and used for several days on the same patient if needed.

Dr. Gross and Lester W. Sauvage, M.D., Elton Watkins, Jr., M.D., and Robert G. Pontius, M.D., who aided in the final perfecting of the apparatus, combined elements from several types of heart-lung machines now in use. The "lung," or oxygenating part of the machine, was adapted from an oxygenator developed by Drs. Earle B. Kay and Frederick C. Cross of Cleveland, and uses rotating discs to film the blood for exposure to oxygen. The number of discs can be changed according to the size of the patient.

Two pumps employed in the machine were developed by Michael E. DeBakey, M.D., Houston, and move the blood through plastic tubes by the squeezing action of rotating rollers.

Dr. Gross' research has been aided by grants from the American and the Massachusetts Heart Associations.



Robert E. Gross, M.D., shows the heart-lung machine he and his colleagues developed at Children's Hospital, Boston. The oxygenator is shown at the top, with its metal discs for filming blood to be oxygenated. The machine has an elaborate system of controls and signals, so that there is an immediate alarm if some portion of it should cease operation. The machine has been used in 250 operations on the heart and nearby great blood vessels, without the loss of a single patient from perfusion.

Heart Can Be Revived With Closed Chest

A closed chest technic for reviving a stopped heart has been announced by W. B. Kouwenhoven, Dr. Ing., James R. Jude, M.D., and G. Guy Knickerbocker, M.S.E., Johns Hopkins University School of Medicine, Baltimore.

The method consists of applying pressure with one hand on top of the other vertically downward on the patient's breastbone about 60 times per minute. At the end of each pressure stroke, the hands are lifted slightly to permit full expansion of the chest.

The pressure on the breastbone compresses the heart between it and the spine, forcing out blood while relaxation of pressure allows the heart to fill.

At first, the researchers thought the technic would be applicable only to children, whose ribs were known to be flexible. However, they found the chest of an unconscious adult to be "remarkably flexible."

Quick Chest Blows May Start Arrested Heart

A sharp, fast blow on the patient's chest may start a heart that has stopped due to cardiac arrest, states John T. Brandenburg, M.D., Medford, Oregon.

Dr. Brandenburg reports that three successive chest blows revived a patient who had been brought into the hospital after a heart attack. Though conscious when he entered the hospital, the patient suddenly "passed out," and pulse and heart tones stopped abruptly.

Death due to cardiac arrest was diagnosed and immediate thoracotomy was considered. But the patient responded to Dr. Brandenburg's blows, and regained consciousness almost immediately. The total time of cardiac arrest was less than one minute. The patient recovered without mishap.

Burns, Eye Surgery Featured in ACS Sessions

More than 1,900 nurses attended the nurses' sessions at the regional meeting of the American College of Surgeons in Boston, February 29-March 3. The following report includes selected abstracts of papers from the nurses' program and from some of the surgeons' sessions of interest to O.R. nurses.

The burned child

Explains Technics to Help Ease Pain of Dressing Change

Contractures may be repaired weeks, months or years after a burn. Late contractures are less serious in an adult than in a child, because a persistent contracture in a child may interfere with proper growth.

The burned child usually has very low morale after surviving prolonged pain. Open wounds must be cleaned mechanically, and the cleaning causes more pain. Immersion in a bathtub of circulating water has helped minimize this pain. Circular bandages are removed, and the child, on a Bradford frame, is quickly immersed.

Once he is no longer exposed to air, he is quite comfortable. The nurse distracts the child with nonsense and chatter, all the while removing the dead skin and cleaning the skin with pHisoHex.

To avoid pain from exposure to air, dressings must be reapplied quickly. At Children's Medical Center we use a combination of dry dressings and tulle gras (a wide mesh gauze impregnated with Vaseline, balsam of Peru, and tincture of benzoin).

In some instances, dressings wet with Zephiran chloride are used.

It may be several days or weeks after this treatment before granulations are firm, cherry pink, and disinclined to bleed easily. The need for grafting to preserve function and relieve contractures is dramatic. Children are seldom put in casts because they wiggle and squirm into positions that defeat the purpose of immobilization. Elastic bandages and Elastoplast allow enough freedom for the child, and better results are achieved. — *Donald W. MacCollum, M.D.,* assistant clinical professor of surgery, Harvard Medical School, and chief plastic surgeon, Children's Hospital Medical Center, Boston.

Extent of Child's Burn Should Be Determined at Admission

As soon as a burned child reaches the hospital, three things must be determined:

(1) Estimated percentage of body burned, (2) depth of the burn, and (3) body parts involved.

When computing the percentage of body burned in children, the head is figured as 19 percent because it is disproportionately large. "One" is subtracted for each year of life and one-half is added to each thigh. By age 11, the rule of 9 used in measuring burns in adults can be applied.

Depth is more difficult to determine. If the skin of the child on admission is pink and sensitive to a pin prick, the burn can be classified as second degree. If the skin is pearly white and a pin prick produces no pain, it is probably a third-degree burn.

This test is obviously not always reliable in a child. A burn involving 10 percent or more of the body surface warrants immediate hospital admission for treatment and intravenous fluids.

The most important feature of care in the first eight hours is fluid therapy to avert hypovolemic shock. The real hazard to transferring a burned patient from one hospital to another is that precious time is lost in starting fluid replacement.

Survey of the admission includes: determining respiratory involvement (tracheotomy may be needed); determining body weight for calculations for fluid therapy; use of narcotics for pain; drawing of blood samples for cross-matching; insertion of a polyethylene catheter in a vein; insertion of a self-retaining catheter; and use of parenteral antibiotics. Clothing is removed; the skin is cleaned with an aqueous antiseptic, and the patient is admitted to a private room.

The untreated severe burn causes shock, which, if not fatal in itself, may result in renal and cerebral damage which may in turn prove fatal. Infection of the wound will occur eventually,

converting a partial-thickness wound to a full-thickness one requiring skin grafting, and serving as a source of blood-stream invasion with pathogenic organisms—the most common cause of death from burns in our experience. Other "complications" of the untreated burn are anemia, severe weight loss, scar contractures, and neuroses.

Five hundred patients have been seen in five years. Fully one-half of these burns were preventable. – *John W. Chamberlain, M.D.,* assistant professor of surgery, Boston University School of Medicine, and surgeon-in-chief, pediatric surgical service, Boston City Hospital.

Burn Treatment Involves Great Expense in Money, Time

Burn patients are no great part of the hospital load. At the Children's Medical Center only four percent of emergency admissions are burn cases. Two-thirds of these are children under 10.

The morbidity may not be great, but the mortality is awesome. The treatment of burns involves great sums of money and a large amount of equipment and supplies. It is often a drain on a hospital's resources. Local charitable funds may have to be used to support patients from distant communities.

More effort is expended on the treatment of burns than any other illness or injury. Hospitalization for the average burn is 105 days—contrasted to 4.5 days for a surgical patient or the average hospital stay of 8.5-9 days. Admissions for grafting and rehabilitation are many and are a great expense to family and community. The average hospital bill for a burned patient is $3,845. One recent case came to $8,000.—*Lendon Snedekker, M.D.,* assistant administrator, Children's Medical Center, Boston.

Eye surgery

Types of Eye Hemorrhages And Principles of Treatment

The ophthalmologist is concerned with two types of eye hemorrhage: (1) that in which there is little blood in the anterior chamber, tension is normal, and the eye heals without problem, and (2) that in which there is massive hemorrhage and serious complications. This type may be a sequel to the first.

When a patient comes in with what appears to be a minor hemorrhage, the possibility of a foreign

body should always be considered. X-ray examination should be routine. Any unexplained unilateral iritis may be a foreign-body reaction. The eye with massive hemorrhage must be examined in great detail. Shortly after injury, the eye should be dilated and the fundus explored. The periphery must be examined slowly with a lens. If there is any question, the whole area should be explored in the operating room.

There is little unanimity on treatment. In treating the first type, the value of bed rest is related to the type of patient. A patient who is more restless and thrashes if confined to bed is better controlled if allowed some leeway for activity. A day or two with binocular bandages is usually enough to impress him with the need for rest and limited activity.

From the second to the fifth days, secondary hemorrhage should be watched for. Sedatives may keep the restless patient quiet. Depending on the condition of the eye, it is best to do as little as possible.

Hot or cold compresses are not advisable. The less done to the eye, the better. Because no disease of the blood-clotting mechanism is involved, there is no indication for drugs to treat such problems.

These are usually direct trauma episodes. No capillary fragility is involved; blood dyscrasias are rare. If multiple hemorrhages persist, one would be justified in exploring the latter factor. There is no use for steroids either locally or systemically, and there is practically nothing to be gained from the use of enzymatic agents.

Treatment of the second type of hemorrhage is more complicated. Blood staining of the cornea should be avoided. Increased tension must be treated; intravenous urea may be helpful. If tension is not relieved in 24 hours, the anterior chamber may be incised.

If irrigation is unsuccessful, less damage and danger are likely if the incision is enlarged and the clot removed. Thrombin appears to be of no real value as irrigating fluid. The changes of secondary hemorrhage do exist, but the alternative may be an even worse prospect.

As long as the pressure remains within normal limits, clot removal can be delayed in most instances. If there is persistent active bleeding into the anterior chamber, the bleeder should be found if possible. A large bubble of air may be hopefully injected to control bleeding.—*Arthur Gerard DeVoe, M.D.,* professor and chairman, department of ophthalmology, Columbia University College of of Ophthalmology, Presbyterian Hospital, New York City.

Tells Use of Plastics In Ophthalmologic Surgery

A few examples of the successful use of plastics in ophthalmology are silicone rubber wicks for maintaining filtration after surgery (one monkey with an implant three months old exhibited no reaction); polyethylene tubes and silicone tubes in retinal surgery; silicone in varying viscosities to replace vitreous (in experimental animals, the silicone has been tolerated up to two years with little reaction); and polyethylene tube or thread as stylettes for epithelialization or maintenance of patency when the lacrimal duct is removed or lacerated.

Although corneal transplants have been more successful recently (the incidence of clear grafts has risen from 27 to 64 percent), there are still a good number that do not remain clear. Inert plastic corneas are being explored to supplement corneal transplants from eye banks.

Methyl methacrylate is molded and machined to an exact convexity and size. It is carefully polished, using polishing dies instead of polishing materials such as emery or rouge which incite foreign-body reaction. In a series of rabbit subjects, plastic corneas are clear after four years and three months. No human subjects have been used yet.

Methyl methacrylate can also be molded to repair orbit deformities, eliminating the need for cartilage grafts.—*William Stone, Jr., M.D.,* director of ophthalmic plastics laboratory and assistant surgeon, Massachusetts Eye and Ear Infirmary, Boston.

Reviews Newer Sterilizing Methods in Eye Surgery

It is misplaced faith that relies on chemical disinfection of instruments. Few germicides have any sporicidal or virucidal effect. Homologous serum jaundice can be transmitted through a prick with a contaminated instrument.

Opthalmologists should not be satisfied with sanitization of their instruments; they should insist on sterilization. Steam and dry-heat sterilization are ideal. Heat-resistant spores should be used to check the efficiency of heat sterilizers. If these are killed during the usual sterilizing cycle, one can assume all other organisms present are also killed.

Not all reports can be taken at face value, however. Good bacteriological testing methods are necessary because false results can be attained from using strains which are not sufficiently heat-resistant or from testing with low spore counts. Not all media are suitable for sterility testing.

A complete cataract set can be sterilized at 140° C. dry heat for six hours. Stainless steel instruments, including scissors, can be autoclaved in steam at 112° C. Ethylene oxide and beta propiolactone sterilization are not intended as substitutes for either steam or dry heat. They do have value, however, for sterilizing non-heat-stable equipment.

One portable ethylene-oxide sterilizer on the market currently is not safe for use if the manufacturer's instructions are relied upon. There is no kill in the two-hour exposure period recommended because there is no humidity control and humidity is essential.

Beta propiolactone which is liquid at room temperature is highly soluble in water. It too needs high humidity to be effective. It penetrates poorly but is useful when surface sterilization is the goal.

Any of a variety of readily available containers can be used with BPL, provided each is fitted with a snug lid. Two filter discs are fixed inside the lid of a dressing can, for example. A few drops of water are placed on one disc and about 0.1 cc. of BPL is put on the other. The instrument to be sterilized is placed in the can, and the lid is put in position. After one hour, the instrument can be removed and will be sterile.

Beta propiolactone vapors are heavier than air and will disperse downward. When sterilizing such things as light cords, the maximum surface area possible should be exposed. The technic can be used with a polyethylene bag to sterilize an operating microscope. Instruments have been deliberately contaminated with spore suspensions. After one hour exposure to BPL, cultures have been negative.

Because BPL is extremely toxic to the cornea, instruments which will reach the eye should be rinsed in sterile, normal saline before use.—*Henry F. Allen, M.D.,* assistant clinical professor of ophthalmology, Harvard Medical School, Boston.

(The following four abstracts are from papers presented at the seventh national congress of the Association of Operating Room Nurses in New York City, February, 1960)

Light Coagulation New Ophthalmologic Treatment Device

The light coagulator, a huge ophthalmoscope with a high-pressure arc as the light source, is probably the most significant new treatment device in ophthalmology. The light, which can be made more brilliant than noonday sunlight, is produced by an electrical arc between platinum electrodes in a glass tube filled with high-pressure Xenon gas.

The light passes through lenses and filters to a

reflecting direct ophthalmoscope. With only two percent of the light, the surgeon aims the coagulator light beam, then electrically releases the full power when he is focused on the right area of the retina. This process – photocoagulation – produces a light beam in a second or less – a light beam, but not a heat beam.

The basic premise for the behavior of the light coagulator is that light produces heat only when it is absorbed, such as in the pigmented choroid or iris. It produces little or no heat when passing through clear, transparent structures, such as cornea, lens, and vitreous. The retina, too, is normally transparent and gets no coagulation from the light unless it is against the pigmented choroid. Thus any elevated retinal detachment is not affected by the light coagulator.

This severely limits the use of the light coagulator in the treatment of retina detachments, since it can be used only in existing retinal detachments when: (1) the retina spontaneously flattens enough to let the tears reach the choroid, and (2) the choroid has been brought against the retinal hole by prior regular surgery.

The great value of the light coagulator is to prevent retinal detachment. It is also valuable in treating tumors of the eye, because it can obliterate small tumors without sacrificing the rest of the patient's sight. It may even have some use in glaucoma after further research.—*Donald M. Shafer, M.D.*, Manhattan Eye, Ear, and Throat Hospital, New York City.

Consider Emotional Factors In Cardiac Surgery

Preoperatively

There are important psychological mechanisms essential to understanding the ways which heart disease and the prospects of cardiac surgery influence the patient's emotions. The emotional factor in cardiac surgery is often a matter of survival and failure to appreciate its importance may cheat surgeons of a well-earned triumph. But what is even worse, it may cost the patient his life.

During the past three years at Montefiore Hospital, both Dr. Janet Kennedy and myself have been studying emotional and psychological behavior of patients undergoing cardiac surgery. We believe that during the preoperative evaluation period it is possible to predict with considerable accuracy the development of postoperative psychiatric complications. With such knowledge, it is often possible to lessen the anxiety before operation or, at least, to be on the alert for dangerous psychiatric states after the operation. And, the incidence of dangerous psychiatric states in cardiac

surgery far exceeds that encountered in all other types of surgery.—*Hyman Bakst, M.D.,* physician-in-charge, psychiatric section, Montefiore Hospital, New York City.

* * *

Postoperatively:

There are conscious stresses that face all patients who undergo any type of surgery, which are familiar to us all. But the unconscious stresses are less familiar. Psychoanalysis has uncovered the deeper basis for the dread of surgery with the analysis of dreams, associations, and memories of individuals who have had operations.

The fusion of the psychological impact of heart disease and the psychological dread of surgery creates a situation with maximum tension and anxiety. This usually occurs at the point where the patient with heart disease is referred for evaluation for cardiac surgery, for the cardiac evaluation occurs in a setting of mounting stress. This stress may be great enough to cause some patients to develop psychiatric complications at this point.

Every patient meets his chronic illness with healthy or neurotic, appropriate or inappropriate defenses. The additional anxiety of cardiac surgery makes it necessary to add emergency defenses to these long-term defenses. These emergency defenses may appear just preoperatively, immediately postoperatively in the recovery room, or some months after the operation. The defenses may be inadequate or unsuccessful. Hysterical amnesias occur postoperatively; also, border-line psychoses, such as serious depersonalization, may occur.

Sometimes the fear of surgery is so great that no defense can be built, and total panic occurs. Then it is best to cancel the operation until the patient can be helped to accept the idea of surgery.

Very often patients will displace their anxieties about the operation onto minor procedures such as the fear of the needle or complaints about food, or nurses, or doctors, or the hospital. Other patients may become extremely demanding and need constant demonstration that the staff is interested in them. Then there are patients who appear to be totally detached from the situation. They make no contact with the staff and ask no quesions about the operation or its after-effects. These are the paients who have the potential of developing psychiatric complications in the postoperative period.

Obviously, even the most psychologically normal patient needs help in facing an operation that is so realistically and intensely anxiety-producing. We have found that even the mere act of psychiatric interviewing to gather data for this study has reduced the frequency of postoperative psychiatric complications.—*Janet Kennedy, M.D.,* psychiatrist-in-charge, psychiatric service, Montefiore Hospital, New York City.

New Chemotherapy Technic In Cancer Treatment

The isolation perfusion technic came into being because of many different and unrelated events. The beginning occurred when the Germans bombarded the British position with mustard gas on July 12, 1917. Subsequently, doctors noted that patients, who seemed to be recovering from superficial burns, suffered gastrointestinal ulcerations and severe depressions of their white cell count. It occurred to clinicians in cancer work that mustard gas might be modified and applied to the treatment of leukemia, since it had specific effect on depressing white cells. Nitrogen was substituted for sulphur, and nitrogen mustard was the result.

But nitrogen mustard as originally administered was found not to be a cancer cure. And, unfortunately, when the dosage was increased high enough to destroy the tumor, the drug destroyed the patient as well.

In 1953, in this country, an attempt was made to increase the concentration of nitrogen mustard directly into the artery supplying the tumor. Although the drug succeeded in affecting the tumor, the undesirable effects on the bone marrow and the artery used made it unsatisfactory as a treatment.

About the same time in England, a group working with x-ray therapy found that an increased oxygen concentration in the atmosphere which the patient was breathing during x-ray therapy of a tumor seemed to increase the effectiveness of the x-ray treatment.

The concept of isolation perfusion was a combination of these two unrelated observations. Isolation perfusion depends on whether the tumor is still confined to an area which can be perfused and whether the blood vessels supplying the area of the tumor can be isolated. It was hypothesized that if the area of the tumor could be isolated from the body as a whole and if a high concentration of the chemotherapeutic agent could be injected into the artery supplying the tumor without the drug escaping into the general circulation, and if the oxygen concentration in that tissue could be raised by the use of the pump-oxygenator unit (similar to that used in cardiac surgery) an increase in the activity of the drug in the area of the tumor might be possible.

There is histological evidence that this hypothesis is true, that tumors do react to this technic. But there is also evidence that the drug does not destroy all tumors. Some respond better than others. However, we cannot accurately predict which tumors are going to respond to this treatment. In a group of some 50 patients under study, there were no cancer cures, but a number of patients had good palliative relief.

Now that we have the method for delivering the drugs, it is our hope that in the near future the chemotherapist will give us the drugs to which tumors can respond and drugs whose actions can be predicted.—*James R. Malm, M.D.,* attending surgeon, Francis Delafield Hospital, New York City.

(Abstract of a paper presented at the 1959 clinical meeting of the American Medical Association)

Extracranial Lesions Yield To Patch, Arterial Grafts

The observations that many strokes are extracranial and that obstruction may be well localized to a short segment of artery have made more effective therapy possible, since such well-localized extracranial lesions are amenable to surgical treatment.

Obstructing lesions involving short segments of artery may be removed by endarterectomy. The involved artery is simply opened in the region of the disease and the obstruction involving the inner wall is removed. To prevent arterial constriction, the incision in the artery is repaired by inserting a patch graft. The free edges of the arterial incision are sutured circumferentially to the edges of the graft.

Longer obstructions are treated by inserting an arterial graft made of knitted dacron. The graft is inserted in such a manner as to bypass the obstruction, and the patient's blood is shunted around the obstruction.

Of 401 patients in whom arteriograms were performed, 160 (40 percent) had obstructions located in the cervical or thoracic segments of the arteries supplying blood to the brain, and 172 obstructing lesions occurring in 136 patients were well localized and amenable to operation. Normal circulation was restored in 165 of the 172 localized lesions submitted to operation.

Recurrence of symptoms and progression of the disease has been prevented in patients with transient attacks or "small strokes," and improvement or complete relief has been obtained in the majority of patients who had persistent difficulties at the time of operation.

Symptoms of cerebral arterial insufficiency due to the curable extracranial lesions are essentially the same as those occurring in patients with untreatable lesions located in the brain, and include weakness, paralysis, aphasia, numbness, dizziness, visual disturbances, and mental deterioration. However, patients with extracranial lesions in earlier stages frequently have brief episodes of symptoms from which recovery may be complete.

Unfortunately, these attacks recur and frequently become worse. Because of the progressive nature of the disease, investigation and study during the

earlier stages is very important so that treatment may be instituted before irreversible damage occurs. Accurate diagnosis is possible only by performing an x-ray examination visualizing all arteries supplying blood to the brain. — *Michael E. DeBakey, M.D.,* professor of surgery, Baylor University College of Medicine, Houston, Tex.

(Abstract of a paper given at the 1960 annual convention of the American Medical Association)

Fenestration of Oval Window Effective in Restoring Hearing

After 1,400 procedures performed over a span of four years, we predict that 94 percent of all patients, ranging in age from 5 to 82, can have hearing restored to an acceptable level using the technic of fenestration of the oval window, rebuilding the sound-conducting mechanism of the middle ear with a vein graft and plastic implant and closure of the middle ear.

Modifications in initial attempts at this repair include removal of the entire footplate and generous saucerization of the oval window. Improvement in results appears to have been concomitant with these changes in technic.

Complications are few. Infection is controlled with meticulous aseptic surgical technic, with particular attention to cleaning and disinfection of the surgical field. The vein itself attaches quickly to the margins of the oval window, creating a seal that efficiently impedes the transmission of infection.

Hearing loss is a potential hazard, but in 1,400 cases only one percent have sustained any degree of loss, and only half of one percent have sustained total hearing loss. Eliminating undue trauma to the cochlea by abandoning the use of chisels is believed to be one factor responsible for the low failure rate. Abandonment of stapes mobilization and selection of patients who have not had previous mobilization are also believed important in achieving good results.

Six patients in the 14 sustaining some hearing loss had had previous stapes surgery, and two had had fenestration of the horizontal semicircular canal.

In five cases, hearing loss is believed to be the result of surgical injury to the membraneous labyrinth, the presence of residual bone fragments in the vestibule, or too deep implantation of the polyethylene tube in the vestibule (in two patients in whom the incus was missing and difficulty was experienced in wedging the tubing beneath the malleus).

Failures appear to be due to the formation of

scar tissue deep in the oval window where the vein contacts the plastic tubing when space in the oval window is limited. The situation is remedied by complete removal of the implant, vein, and scar tissue and replacement with a finer graft.

The major threat to success is bony closure of the fenestra. The incidence is low, but the situation does occur, and apparently repair by further surgery is not advised.

Vein grafts removed for diverse reasons have been found to be intact, normal in appearance, and free of scar tissue.—*John J. Shea, Jr., M.D.,* Memphis, Tenn.

(Abstract of a paper presented at the 1960 convention of the American Academy of Orthopaedic Surgeons)

Poured Liquid Plastic Used in Fracture Fixation

A liquid plastic which hardens into a strong solid has been developed and used in the treatment of fractured and diseased bones. The plastic possesses the proper qualities of strength, osteogenesis, nontoxicity, cohesiveness and ease of handling at surgery necessary for maximum efficiency in bone fixation.

Called Ostamer, it provides a chemical lacunar system. New bone not only grows along the surface, but also through the plastic, as in the case of an autogenous graft. This form of fixation permits earlier ambulation of the patient and more rapid return to physiologic norm than do other forms of treatment.

Fracture of the femur is ideal for Ostamer fixation because of the abundance of muscle and soft tissue covering the femoral shaft, and because of the size of the medullary canal of the femur. Ostamer can be placed within the medullary canal, reinforced if necessary by intermedullary support, and further supported by a reverse inlay graft. An additional pour of Ostamer can be applied to the outer cortex.

When infection is present Ostamer remains unaffected and permits bony union, as long as weight bearing is continued. In one case studied, the infection was so virulent that the inlay graft was completely sequestrated, but the plastic was undisturbed and union was obtained.—*Michael P. Mandarino, M.D.,* Philadelphia; *Joseph E. Salvatore, M.D.,* Memphis, Tenn.; *Thomas L. Jones, M.D.,* Cincinnati.

Palate Surgery Reduces Hearing Loss

Children who have a cleft palate surgically repaired before they are 18 months old have a better chance of avoiding the serious hearing loss often

associated with the condition. So state Frank W. Masters, M.D., H. L. Bingham, M.D., and David W. Robinson, M.D., Kansas City, Kan.

In research conducted over the last five years, the doctors report that fewer than one out of three children under 18 months suffered hearing loss after surgical repair. Ordinarily, one of every two children with the malformation develops hearing difficulties.

According to the researchers, children who are fitted with a prosthetic device to cover the split palate are most susceptible to hearing loss – the ratio is three out of four.

Early surgery which closes and lengthens the palate is most likely to achieve a normal relationship between palatal muscles and Eustachian tubes, and to reduce middle ear infections, add the doctors.

Ice Water Favored As First Aid For Burns

Eight years ago, upon burning his hand with boiling grease, Los Angeles M.D. Alex G. Shulman plunged it into a tub of cold water because it seemed a "logical" way to alleviate pain. His assumption was proved to be correct; moreover, subsequent healing took place more rapidly than usual. Dr. Shulman therefore adopted the technic for his patients with first degree burns.

In a recent issue of the *Journal of the American Medical Association,* Dr. Shulman states that whatever the subsequent treatment, patients who receive initial ice-water treatment fare better than those who do not. Pain that would ordinarily last 24 hours or more has been relieved at once and the usual inflammatory process secondary to burns has been reduced or even reversed by icewater therapy. One hundred fifty patients have been treated with success.

His method is to either place the burned area into a basin containing tap water, ice cubes and hexachlorophene, or to apply towels chilled in ice water. The treatment is continued till it can be stopped without return of pain, a period ranging from 30 minutes to five hours.

Radiation a Factor In Kidney Transplant

A team of doctors from Harvard Medical School and Peter Bent Brigham Hospital, Boston, have described the first successful attempt to graft a kidney from someone other than an identical twin.

The doctors, led by John P. Merrill, M.D., took a healthy kidney from Andrew Riteris and transplanted it to his brother John, who had exhibited symptoms which included severe high blood pressure, a failing and much enlarged heart, dropsy, and anemia.

To help the graft take, and to prevent the usual rejection reaction, radiologist James B. Dealy, Jr., subjected John to a total of 450 roentgens in two doses.

In another major operation, John's own diseased kidneys were removed. About nine months after the transplant, his system began to rebel against the new kidney, and an additional dose of 200 r. was given. John has survived in good health since then, and the Brigham Hospital team is hopeful that nature's usual reaction to invasion has been overcome in this case.

ASEPTIC TECHNIQUE FOR OPERATING ROOM PERSONNEL.
By Erline Webb Perkins, R.N., B.S., M.S. in N. Ed. Philadelphia: W. B. Saunders Co., 1959. 112 pages.

This operating-room manual of practical nursing is also useful in training operating-room technicians or surgical aides, medical students functioning as technicians, and nurses of any basic program.

Written to fulfill the request of licensed practical nurses for additional training, the manual gives the basic principles for scrubbing and circulating in an operating room, and includes information on the basic sciences, sterilization, development and principles of aseptic technic, and preparation of the patient for surgery. Discussions are presented on responsibilities of operating-room nurses, materials used in the operating room, and the basic considerations in all types of surgery.

Teaching aids for the instructor include a suggested activity list and a student evaluation record.

THE SURGEON AND THE CHILD.
By Willis J. Potts, M.D. Philadelphia: The W. B. Saunders Co., 1959. 225 pages. $7.50.

This is the story of children's surgery written for the obstetrician, pediatrician and generalist who must treat the patient who has "no language but a cry."

Drawing on both his own experiences and those of the Chicago Children's Memorial Hospital staff, Dr. Potts covers problems of psychology as well as physiology.

Winning the confidence of child and parent — deciding when continued hospitalization is more dangerous to a child's emotional system than a help to his physical well-being — these are some of the problems covered in the book.

Dr. Potts also analyzes problems of preoperative and postoperative care, and cardiac arrest and administration of anesthesia during the operation.

The book is not intended as a text on pediatric surgery; its primary concern is diagnosis and treatment in this rapidly growing field.

Criteria of diagnosis and surgery are suggested for respiratory and pulmonary problems, jaundice, hernias, tumors, digestive tract and rectal malformations and appendicitis. In all, some 28 infant surgical ailments are considered.

Pitfalls in Pediatric Anesthesia

By M. Digby Leigh, M.D.*

The balance is delicate between life and death in infants and young children, particularly in the premature and newborn, and they can die during anesthesia without warning that a complication has arisen. The main reason for such an abrupt demise is that the infant or young child has a relatively small reserve of oxygen combined with a high consumption of oxygen.

Added to this physiological handicap, other characteristics of the premature infant, such as his unstable temperature, underdeveloped lungs, low blood pressure, anemia, and poor kidney function, can lead to many pitfalls in pediatric anesthesia, as proven by the present relatively high mortality rate of 25 percent following surgery in this age group. Consequently, unrelenting attention to every detail of the management of the anesthesia, including the preanesthetic preparation and postanesthetic care, must be the steadfast rule of the pediatric anesthesiologist.

The first detail demanding exacting attention is the preanesthetic assessment of the over-all condition of the patient, which means an assessment of the function of every system of the body. To demonstrate the necessity for such a thorough appraisal, reference will be made to some of the conditions that can have a significant influence on the management of the anesthesia.

The patient with infection, elevated temperature, or dehydration may convulse during anesthesia. Sweetened fluids given orally or intravenously before anesthesia will prevent this complication.

The patient with a chronic infection has reduced cardiac reserve and anemia, and therefore is susceptible to cardiac depression or hypoxia from even a slight overdose of anesthetic agent.

The patient with a ruptured appendix and peritonitis may fail to withstand the operation and anesthesia unless his body temperature is reduced

*Dr. Leigh is director, division of anesthesia, Children's Hospital, Los Angeles. This article is taken from a paper presented before the annual meeting of the Chicago Medical Society, March, 1960.

below normal by placing him on an ice-water mattress.

Diseases which interfere with the patient's respiration cause grave concern to the anesthesiologist. Included in this category are asthma, cystic fibrosis, poliomyelitis, myasthenia gravis, congenital amyotonia, and a brain tumor. When any one of these conditions is superimposed upon the normal risks of anesthesia and surgery, the consequence may be death postoperatively unless the patient is given only minimal doses of sedatives and anesthetic agents, so that immediately upon completion of the surgery he is awake and can be induced to cough.

Often it is not realized that children can be afflicted with serious heart conditions from a variety of causes. For instance, a mother with diabetes may produce an infant with an enlarged heart or hyaline membrane disease. A hypertensive mother may have a hypertensive infant. An infant or child with asthma of long duration is burdened with an added strain on the heart, and should be treated preanesthetically with pressure breathing exercises.

Occasionally, a child with congenital heart disease (a "blue baby," for instance) may be scheduled for repair of a hernia or a cleft lip. The contemplation of such an event causes grave concern for everyone involved, and raises the perplexing problem of whether the congenital heart defect should be corrected before the hernia or cleft lip is repaired.

Requiring careful consideration is a patient with anemia from infection or malnutrition, which causes fatty degeneration of the heart and reduced blood volume. As a consequence, the patient has very little cardiac reserve, and small quantities of anesthetic agents or a brief period of hypoxia may cause the heart to cease functioning in a few seconds. Iron therapy for several days preanesthetically is advisable, for it usually corrects the anemia, or a preanesthetic transfusion of blood may be necessary.

A patient with a digestive disorder, such as celiac disease, may be cachectic and thus a candidate for cardiac arrest unless light anesthesia is maintained.

One of the most serious and frequently seen risks in anesthesia is a patient with a stomach full of food, since this food may be aspirated into the lungs during anesthesia. Even a very small infant retains food in his stomach for four to five hours. Solid food including milk should be withheld for at least five hours before anesthesia. Even then, the anesthesiologist must always be prepared by having a large mouth-aspirator close at hand during the induction, maintenance, and recovery periods. He must also be prepared to turn the patient on his side and to tilt the head of the table down.

The urine of the patient should always be examined before anesthesia. The presence of acetone and diacetic indicate an acidosis, which calls for treatment with antiacidotic fluids before anesthesia. Rarely, a diabetic or nephritic may be detected during a routine urinalysis. Such detection enables the patient to have the benefit of treatment and undergo surgery with less likelihood of complication.

Other systems of the body may be afflicted with disorders unrelated to the disease for which surgery is scheduled. The effect of the particular disorder upon the conduct of the anesthesia must be carefully evaluated.

Arousing interest in the preanesthetic evaluation of the patient and consequently the selection of anesthetic agents is the recent recognition that many drugs administered before surgery for treatment of a specific disease are synergistic with certain anesthetic agents, and as a result, enhance the risk of anesthesia. For instance, tranquilizers, followed by narcotics or hypnotics may cause prolonged respiratory depression, resulting in a slow return to consciousness.

Streptomycin and neomycin may prolong the effects of muscle relaxants. Magnesium sulfate may prolong the muscle-relaxant effect of curariform drugs, just as ether does. Respirine when combined with some anesthetic agents may cause a depression of circulation during surgery. Insulin without a balanced glucose intake may cause a postanesthetic insulin shock in a juvenile diabetic.

If the patient has been receiving quinidine, and ether is used during anesthesia, the ether must be metered carefully, for large doses will depress the cardiovascular system.

The combination of an anesthetic agent with epinephrine (Adrenalin) or phenylephrine (Neosynephrine) eye drops may cause a marked rise in blood pressure. Cyclopropane and halothane (Fluothane) are contra-indicated if epinephrine is to be administered, because the joint action of these drugs may cause a ventricular fibrillation. Highly digitalized patients may show increased irritability of the heart, and drugs such as epinephrine or calcium may further increase this irritability and initiate a ventricular tachycardia or fibrillation. Cocaine and epinephrine are said to by synergistic and when combined may lead to a ventricular fibrillation.

On the other hand, certain drugs are antagonistic to one another. For example, recent studies indicate that heparin may counteract the effect of a muscle relaxant. There is, therefore, a tendency to give larger doses of the muscle relaxant to achieve the desired state of relaxation. Then, at the completion of the surgery when the heparin is neutralized, the antagonistic effect of the

heparin is removed and the full effect of the large dose of the muscle relaxant is seen, with the result that prolonged apnea may occur.

Also requiring consideration preanesthetically is the proposed positioning of the patient for surgery. Placement of the patient in the upright position for a neurosurgical procedure may produce hypotension, a fact which the anesthesiologist must bear in mind when planning the management of the anesthesia. Then again, the prone position during any procedure may restrict the breathing unless the patient is intubated and artificial ventilation of the lungs is maintained.

Another recommended precaution is to have cross-matched blood ready before surgery if a loss of blood is anticipated.

Although the foregoing brief review covers only some of the features which may complicate the management of the anesthesia, it does reveal that the preanesthetic evaluation and preparation of the patient are integral parts of safe pediatric anesthesia.

During anesthesia certain basic principles are mandatory. These are: maintenance of a clear airway; maintenance of adequate pulmonary ventilation, supplying sufficient oxygen for metabolic needs and an efficient washout of carbon dioxide from the lungs; avoidance of overdosage of anesthetic agents; immediate replacement of blood loss, and avoidance of pyrexia.

An example of inadequate pulmonary ventilation which is often overlooked is that which is initiated by prolonged, sustained coughing without an adequate breath during continuous aspiration of a throat. Therefore, between aspirations, oxygen should be administered with a bag and mask. If an endotracheal tube is in place when the patient is straining for a breath, compression of the breathing bag will supply him with oxygen.

One of the weapons employed to combat the pitfalls of pediatric anesthesia is equipment that provides a *continuous* monitoring of the cardiovascular system during the entire course of the anesthesia, for in many instances in which the patient is not breathing spontaneously, an early depression of the cardiovascular system may be the only indication of an overdose of anesthetic agent or of hypoxia. The traditional, intermittent recordings of blood pressure are still taken when monitors are used, because decreasing pulse pressure and rising pulse rate may be indicative of decreased cardiac output. These occasional blood-pressure recordings also serve as a spot check on the continuous monitors.

Some of the monitors which have proved of inestimable value by providing a running second-to-second picture of the condition of the patient are the precordial or esophageal stethoscope, the

pulse-wave plethysmograph, the electrocardiograph, the electroencephalograph, and particularly the rapid infrared carbon-dioxide analyzer.

Individual assessment of the merits of these monitors is advisable, since the scope of monitoring afforded by each one is not comparable. However, they all enable the early detection of conditions which if allowed to continue unabated might lead to a cardiac arrest.

In summary, it is suggested that only with an understanding of the normal and abnormal conditions and diseases of the infant and child and the effects of treatments administered for particular conditions can the pediatric anesthesiologist properly evaluate and prepare the patient for anesthesia. Then, he must be ever mindful of these characteristics and the possible consequences during the superimposition of the risks of anesthesia. Being thus mindful, he will use the anesthetic agents, technics, and equipment best suited to provide the safest possible course of anesthesia and recovery period for the infant or child in his charge.

PEDIATRIC ANESTHESIOLOGY. Second Edition.
By M. Digby Leigh, M.D., and M. Kathleen Belton, M.D., New York: The Macmillan Co., 1960. 461 pages. $12.00.

This second edition of *Pediatric Anesthesiology*, written 10 years after the initial volume, is completely rewritten rather than merely revised. Expansion in the book's scope represents the phenomenal growth in thought and action of the still-young specialty, pediatric anesthesiology.

The book is intended primarily for those engaged in administering anesthesia to infants and children — physicians, dentists, nurses — but it is also intended for those who are responsible for the over-all welfare of the infant and child — the pediatrician and the general practitioner.

The book is divided into four sections. Section one describes the preanesthetic evaluation of the child, and contains summaries of a number of pediatric diseases and their effect upon the management of anesthesia.

Section two covers the pharmacological effects on anesthetic agents, and delves into the basis upon which the selection of anesthesia is made. This section also contains a description of anesthetic equipment and explains the necessity for conscientious preparation of such equipment.

Sections three and four describe preanesthetic medication and preparation, and outline the management of the anethesia for certain surgical procedures. Also included are chapters on the anesthetic management of the premature and newborn infant and on the postanesthetic management of the infant and child.

(The following four abstracts were taken from TOPICS' report on the 1960 meeting of the International Anesthesia Research Society)

Prompt Recognition and Treatment Needed in Pediatric Shock Cases

Pediatric surgery has advanced so that it is not uncommon to submit a frail newborn or infant to three or four hours of major surgery. But this advancement makes it more important to understand, recognize and treat shock in pediatric cases.

Predisposing conditions which make some children more susceptible to shock than others are: poor vasomotor control in the premature child; dehydration or acute illness in the febrile patient with peritonitis and acute appendicitis, hypovolemia in the patient with a growing tumor; unexpected appearance of adrenal dysfunction and malignancy, especially in the child with an abdominal tumor.

Myocardial failure, hepatic disease, and hypoxic states are seen frequently in the child with congenital heart disease. Tonsillectomy and adenoidectomy bleeding is also a source of trouble. Patients suffering this are susceptible to shock and should be watched closely. In fact, any child undergoing surgery which requires much dissection, resulting in heavy bleeding, may develop shock.

Although the patient may not have a single, marked hemorrhage, he may gradually lose his entire blood volume and go into shock. Surgery on tumors of the upper abdomen, such as neuroblastoma and Wilms, have caused shock and subsequent death in many patients, and no sensible conclusion has been reached by the surgical team on how to prevent it. Severe burns, whether in the new, recent, or grafting stage, can produce bleeding and other shock manifestations.

High-risk patients should be given careful surgical preparation, and surgery should be performed only if they are in an optimum condition. A presurgical blood-volume study should be made for all children, especially those with growing tumors. This will prove useful if the patient is to receive numerous transfusions. If the child is going to be in a sitting position and peripheral dilatation or shock is a possibility, his extremities can be wrapped in bandages.

The operating room should be warmed before submitting a child to surgery. Most operating rooms are kept at 68°F. If a child is exposed in this temperature, his temperature can drop to 88 or 84°F. within one and a half hours. Lowering a child's temperature to such a point may hinder his shock tolerance.

The choice of anesthetic is difficult in a patient who may become hypovolemic. For a long time cyclopropane was believed to be the only agent to

give in such a case. Now we believe ether is preferable because it enables easier recognition of blood loss. In the patient receiving cyclopropane, the vessels constrict as he loses blood, but he retains his blood pressure until he is bled out. Then his blood pressure drops suddenly.

Blood pressure can and should be taken for each child about to undergo surgery and the obtained reading maintained throughout the operation. Pulse rate is not a reliable indication of shock. A child who has received atropine and ether can become exsanguinated before his pulse rate increases. Pulse pressure is of greater value because a decreasing pressure is indicative of decreasing cardiac output.

Pulse volume, as it is felt in the peripheral pulsating vessel, is one of the most important indicators of circulating blood volume. The presurgical volume should be maintained throughout surgery. Heart sounds disappear at a late stage of shock and should be used only as a last resort.

Respiratory effects provide an occasional sign of shock. If the child is lightly anesthetized and begins a tracheal tug or jerking respiration, his blood volume is becoming ineffective. If the child is warm, peripheral color is a fairly reliable indication. Also, if the patient becomes suddenly cold or relaxed or develops dilated pupils, shock can be suspected.

If shock should develop, the anesthetic must be immediately suspended and blood replacement carried out rapidly. Blood should be pumped at an accurate rate because too much blood can flood a small patient within 30 seconds. One cc. of calcium should be given for every 100 cc. of blood replaced in a small baby. This should be scaled down in cases where blood is not being rapidly replaced. — *Robert M. Smith, M.D.,* director of anesthesia, Children's Hospital, Boston.

Failures of Anesthesia Procedure Attributed to Technical Problems

Too often there is a tendency to explain failures of continuous lumbar peridural anesthesia on some pseudoscientific basis when, in actuality, failures are usually due to technical problems.

Each variable involved in this technic may be a basis for a particular failure. The local anesthetic solution selected must have a reasonably rapid onset of action and sufficient penetrating power. An adequate strength of solution must be used, and a sufficient volume of local anesthetic agent must be administered initially and intermittently.

Anatomic variations can also be responsible for failures. Deformities or deviations from normal are more common in various vertebral column com-

ponents than generally considered. The most important of these is probably the various ligamentous remnants within the peridural space which interfere with the spread of solution.

Since the local anesthetic solution acts in the mixed spinal nerve distal to the dural cup in the perivertebral space, the size of intervertebral foramina is important in spread of the anesthetic. A complete obstruction of one foramen will cause an unanesthetized band corresponding to the distribution of the respective intercostal nerve. This may produce an apparent failure from an otherwise excellent continuous peridural anesthetic. Similarly, if only small amounts pass through the foramina, only partial anesthesia of short duration will result.

The lumbosacral angle, important in caudal anesthesia, may also be significant in lumbar peridural anesthesia. The greater this angle, the larger the volume of injected solution must be. If an inadequate amount is used, it may run out of the anterior foramina almost as quickly as it is injected, and incomplete or no anesthetization will result.

Incomplete or no anesthetization is frequently reported to follow toxic reactions. This is probably due to drug absorption by the blood stream so that insufficient amounts and/or concentrations reach the perivertebral spaces. This commonly follows blood vessel damage.

Among the other reasons for failure are: the catheter may be plugged or kinked; the needle may be blocked; or the catheter may be severed when the needle is removed. Also, the puncture site selected may be incorrect, or the catheter may not be advanced the right distance.

The adoption of standardized technics based on sound physiologic principles and the reduction of variables to a minimum are the most important factors in reducing failures. Strict adherence to minute details of technic is imperative. —*Peter C. Lund, M.D.,* Johnstown, Pa.

Reviews Continuous Anesthesia Technic Used on Surgical and O.B. Patients

Continuous lumbar peridural anesthesia is a reliable type of conduction anesthesia which provides profound relaxation, produces few neurological complications when properly administered, and can be continued into the postoperative period when chemical sympathectomy is desired.

Occasionally this method fails, however, and to find out why, we reviewed the records of 1,780 surgical and obstetrical patients in whom we applied this technic using two percent lidocaine with 1:2,000 norepinephrine administered through vinyl plastic catheters. Where this method failed, the catheter

was left in place, but anesthesia was supplied by other methods.

There were 36 cases of initial failure of anesthesia, giving an over-all failure rate of two percent. Fourteen of these patients were treated by partial withdrawal of the catheter with subsequent development of successful anesthesia. In the untreated group, there were 22 failures giving an actual failure rate of 1.2 percent. The most common cause of failure – judged by x-rays taken in 17 of these 22 patients – appeared to be improper positioning of the catheter.

There are three possible reasons for this failure:

1) If the needle is not correctly placed in the peridural space, the catheter cannot be inserted into the space and the drug will not enter it.

2) With a correctly-placed needle, the catheter will enter the space, but may be withdrawn from it during the needle withdrawal and the drug will not enter the proper plane. If there is extreme resistance to the drug, this phenomenon can be suspected and the entire block should be repeated.

3) The catheter may enter the space properly but may exit via nearby intervertebral foramen as it advances. In this case, the solution will be deposited in paravertebral tissues.

Because of the advantage of continuous technic and the ease of passing the fine vinyl plastic catheter into the peridural space, we have routinely used a catheter in all but the most predictably short cases. It is unwise to insert the catheter further than 4 cm. into the peridural space, because it may pass a short distance in one direction, be deflected by nerves and blood vessels in its path, and curve and double back in the reverse direction. –*Frederick W. Hehre, M.D.*, associate director, department of anesthesia, Grace-New Haven Community Hospital, New Haven, Conn.

Type of Lesion and Age of Patient Affect Open-Heart Surgery Results

A multiplicity of factors interact to cause death in patients undergoing open-heart surgery. To test our belief that death in these cases is sometimes due to inadequate attention to the more prosaic factors associated with any thoracic surgery – and to determine how these could be better controlled – we studied all deaths associated with intracardiac surgery in our institution.

During the last four and a half years, 110 direct vision repairs of cardiac defects have been attempted. Thirty patients died in the immediate postoperative period. Thirty-five operations were done during the first two years under hypothermia and inflow occlusion. These were confined to repair

of simple congenital defects and the mortality rate was 14 percent.

During the last two and one-half years, we have used extracorporeal circulation exclusively; the mortality rate for 75 operations has been 33 percent. However, during this period, more complex repairs have been attempted.

In congenital heart lesion repairs, good operative results are obtained in children who, because of adequate myocardial reserve, have been able to survive the first three years. The mortality rate is higher in adults, who exhibit a decreasing myocardial reserve with aging. Similarly, in acquired lesion repairs, the younger age group is better able to withstand the profound physiologic changes produced by surgery and cardiopulmonary bypass.

Four factors predominate as the cause of postoperative death: cardiocirculatory insufficiency; persistent bleeding and inadequate blood replacement, in patients with cardiocirculatory instability who lacked the compensatory mechanisms necessary to maintain vascular tone; metabolic acidosis, inadequately treated in the postoperative period; and respiratory problems.

Cardiocirculatory deficiencies produced the highest mortality rates in patients with acquired lesions and in adults with congenital lesions. Persistent bleeding occurred most often in adult patients with associated circulatory instability and poor peripheral vascular control. Metabolic acidosis and fatal respiratory problems occurred more commonly in young patients with congenital lesions.

It's thought that cardiac circulatory derangements are more serious in adults because their myocardial mass has outgrown their coronary blood supply. Hence, they have a relative coronary insufficiency, and the insults of electro-cardiac arrest, inadequate coronary perfusion, and direct trauma to the heart are poorly withstood.

In children, respiratory complications appear to be the most serious problems – due to inadequate respiratory support and inattention to tracheal-bronchial toilet. One 10-month old infant was permitted to form a mucus plug in his tracheostomy tube and died suddenly. Four other patients had seriously impaired breathing mechanisms but received either no support or inadequate support of their breathing with intermittent positive-pressure ventilation.

Inadequate attention to the routine postoperative difficulties may interact with the special derangements of these patients to cause death. For example, a patient with myocardial inefficiency may also have peripheral vascular instability, altered breathing mechanics, atelectasis, and acidosis. If the myocardium can be induced to contract more efficiently, he may be able to tolerate these abnormalities; but the patient with altered respiratory me-

chanics and possible atelectasis will have to work harder to breathe, particularly if he does not have the assistance of an adequate tracheo-bronchial toilet to help keep his air passages clear. Thus, exhaustion, hypoxia, and hypercamia may further depress the myocardium and decrease his myocardial reserve to a critical point. – *Paul R. Hackett, M.D.,* associate professor of anesthesiology, University of Maryland School of Medicine, Baltimore.

(The following three abstracts report on papers presented in a symposium during the 1960 congress of the Association of Operating Room Nurses)

Three Specialists Discuss Use, Abuse Of Hypnotherapy

The Anesthesiologist:

In anesthesiology, hypnosis offers a means of reducing patients' preoperative apprehensions, allaying their fears and anxieties, and instilling a feeling of security and confidence. Simple relaxation hypnotic induction technics serve the purpose of developing patients' confidence in themselves. Patients can be taught quickly and easily without long practice sessions to enter the trance state.

The major use of hypnosis in anesthesia is to support the patient psychologically and as an adjunct to chemical anesthesia. However, there are times when hypnosis is useful, even today, as the only agent.

The pre-anesthetic period is a state of heightened awareness. Hypnosis alters this awareness and utilizes patients' tremendous mental capabilities. It has been and will continue to be a valuable tool for the anesthesiologist to take with him to the patient's room. Hypnosis belongs in medicine and in anesthesiology to fully allow the anesthetist to give better care to his patients.–*D. D. Hutchings, M.D.,* Bath, N. Y.

* * *

The Surgeon:

Hypnosis is thousands of years old and has had several periods of popularity in the past. Today it is experiencing a tremendous rebirth, and interest in hypnotherapy is distinctly on the rise.

A small percentage of our population – possibly 5-10 percent – can be trained to be such excellent subjects as to be able to undergo major surgery under hypno-anesthesia without chemical reinforcement. However, the indications for operating under this condition are few and far between. With chemo-anesthesia as nearly perfected as it is today, almost any surgical patient may receive analgesia or anesthesia. In bad-risk cases, however, the

amount of pre-anesthetic medication may be cut down or eliminated with use of hypnotherapy.

Patients in hypnosis require smaller amounts of sedation and narcotics in the postoperative period to maintain comfort. This makes possible better and faster resumption of nutrition to enhance wound healing and general recovery. I offer all my elective surgical patients the opportunity to learn to go into the hypnotic state either before admission to the hospital or after admission and before surgery because I believe these features are so important.

In addition, many minor procedures may be performed completely under hypno-anesthesia or with minimal amounts of local or general chemo-anesthesia added. Also, hypnosis is of great aid during plastic surgery under local anesthesia and for all types of instrumentation such as cystoscopy, sigmoidoscopy, and bronchoscopy to avoid the discomfort and ill effects of chemo-anesthesia.

Hypnosis is extremely helpful in the passage of a Levine tube, of catheters in the male, in the removal of sutures and packing or painful dressings, in the debridement of severe burns, and in setting minor fractures.

In cesarean section, hypno-anesthesia alone or combined with local or regional anesthesia is invaluable. The adequate oxygen supply and lack of sedation and narcosis protect the unborn infant from cerebral anoxia with possible resultant brain damage.—*William E. F. Werner, M.D.,* director of obstetrics, Rockaway Beach (N. Y.) Hospital.

* * *

The Psychiatrist:

Although we have much to learn about hypnosis, we know enough at this time to postulate certain empirical rules of effective use. In general, we can divide the uses of hypnosis into psychiatric and non-psychiatric. This is important because it serves to focus upon the unique quality of the hypnotic trance, which is an altered state of relatedness characterized by non-rational submission, relative abandonment of executive conscious control, regression, and dissociation, all of these being instigated and enhanced by the hypnotist.

This submission to the hypnotist empowers him to alter sensory perception and modify motor power if he wishes. Further, it puts the hypnotist into the privileged and responsible position of uncovering, if he chooses, many levels and facets of subconscious and unconscious material that the patient would not ordinarily reveal to another, and perhaps not even to himself. Now here is the crucial issue. Under what circumstances can one ethically choose to alter ideation and uncover unconscious data?

The propriety of hypnotic intervention is determined by the therapeutic occasion, and by the competence of the intervener or hypnotist. To the extent that the hypnotist has clinical competence to cope reasonably with the newly established hypnotized status, the use of hypnosis can be desirable and proper. Thus, to alter sensory perception hypnotically for a surgical procedure to a point that chemical anesthesia is either used in less quantity or not all is an appropriate function of a well-rounded anesthetist or surgeon.

Likewise, to enhance delivery with minimal or no chemical anesthesia is obviously a valuable adjunct to the art of obstetrics. Similarly, the dentist who can elicit anesthesia and muscular control without chemicals is adding new dimensions to his professional skill.—*Herbert Spiegel, M.D.,* psychiatrist, William Alanson White Institute of Psychiatry, New York City.

(The following is from the column, "Review of Hospital Lawsuits," by Leo. T. Parker)

Nurse is Negligent

A nurse injured while performing work in a hospital cannot recover damages if the injuries apparently resulted from her own negligence, a higher court held in a recent decision. The court explained that hospital employees must use reasonable care to protect themselves against injuries and must not expect hospital officials to safeguard them against all injuries.

In *Good v. West Seattle General Hospital, 335 Pac. (2d) 590,* the testimony showed that Miss Good, a nurse anesthetist, was seriously injured while moving an anesthesia machine down a ramp in the West Seattle General Hospital, where she was employed. The accident happened when the machine tipped back upon her, pinning her to the floor.

She sued the hospital for heavy damages, claiming that officials of the hospital were negligent in failing to keep the premises safe for its employees, failing to provide a sufficient number of anesthesia machines so that moving one would not be necessary, requiring her to move the machine without assistance, and failing to warn her of the danger involved.

The lawyer representing the hospital contended that the hospital was not liable because the accident was due to the nurse's negligence in attempting to move the machine without assistance, and that she had assumed the risk of such accidents when she accepted employment.

The higher court, in refusing to hold the hospital liable, said that, under the circumstances, the nurse assumed the risk of her injuries.

New Anesthesia Machine

New anesthesia machine developed at Long Island College Hospital, Brooklyn, N.Y., is demonstrated here by Frances Dowiak, R.N. (l.), chief nurse, anesthesia department, to Mrs. Maureen Moriarity, R.N., operating-room supervisor.

One purpose of the anesthesiology department in designing the machine was to incorporate the most modern means of vaporizing and measuring anesthetics in the smallest unit practicable, while still providing sufficient, readily accessible storage space for emergency drugs, equipment accessories, and mechanical breathing devices.

An additional objective was to produce a unit for use of the anesthetic agent Fluothane, a non-explosive, quick-acting agent which has to be controlled exactly. Since the new machine went into use at the hospital, this drug has been used for a large percentage of operations.

The machine, built to the specifications of the department of anesthesiology as a special model, is now available commercially.*

*Manufactured by the Foregger Co., Roslyn, N. Y.

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Anesthesia

By Dorothy W. Errera, R.N.

Walker, Robert V.: "Sterilization of Anesthetic Cartridges in Office Practice." *J. Oral Surgery*. 17:48, November, 1959.

Dental equipment is a potential factor in cross-contamination and spread of infection. Anesthetic cartridges have escaped inclusion in sterilization programs for syringes and needles. The contents are sterile as manufactured, but the problem is to make the cartridges safe for handling in the office, clinic, or hospital.

Chemical disinfection has many limitations. It does not kill the virus of homologous serum jaundice; germicides are diluted when a wet object is immersed; there is negation of germicidal action by incompatible substances; leaky ampoules take in germicide which may not be detected; the anesthetic agent may be inactivated by puncturing a stopper through residual disinfectant which may have a deleterious effect on the drug in the cartridge.

The cartridge is encased in a cylinder made of light-weight cardboard, and the unit is placed in a paper sterilizing bag. The cardboard keeps the bag surfaces apart. The bag is sealed with an ordinary hot iron or a sealing tool, and the bag and its contents are exposed to saturated steam at 250° F. for 30 minutes. The sterilizer is exhausted slowly at the end of the cycle to prevent expulsion of the cartridge contents.

It is imperative that a bag be chosen which is known to be permeable to steam and to provide a protective barrier against contamination after sterilization. The seams and folds must be uniformly sealed during manufacture with a heat-resistant adhesive.

The author has experienced no failures of local or regional anesthesia attributable to any loss of potency of the anesthetic solution.

Davies, Russell M., and Summers, F. H., "Lubrication of Endotracheal Tubes with Polyethylene Glycols." *Brit. J. Anaes.* 31:325, July, 1959.

Attempting to circumvent the disadvantages of lubricants of paraffin or water-based gels, the authors examined various substitutes and standardized on polyethylene glycol.*

There is apparently minimal toxicity. In 5,000 patients no ill effects have been noted. The endotracheal tubes appear to keep their shape and form longer than when paraffin-based lubricants are used.

*555 M Shell Chemical Co.

The polyethylene glycol is sterilized in 1-oz. quantities in dry heat at 150° C. (300° F.) for one hour.

If local anesthesia is desired, the lubricant is made up with 2 parts of lignocaine base and 98 parts of sterile polyethylene glycol.

More fluid lubricants, for use with other tubes, are made up using 5 parts of polyethylene glycol 555m and 95 parts of polyethylene glycol 300.

The glycols are clean to handle and generally less messy than traditional lubricants. Their viscosity equals that of liquid paraffin.

"Current Comments — Inflatable Rest." *Anesthesiology* 20:711, Sept.-Oct., 1959.

An inflatable cuff of conductive rubber (7" x 13½") is fitted with a hand bulb and a shut-off valve. The cuff is placed under the patient and inflated until the patient is in the desired position. Apparently, the cuff is more comfortable and there are fewer complaints of lameness after surgery than when positioning is done with rests or sandbags. The anesthesiologists note no blood-pressure changes during inflation of the cuff.

"Current Comments — Anesthetic Cabinet." *Anesthesiology* 20:712, Sept.-Oct., 1959.

The ordinary mechanic's roller cabinet makes an ideal anesthetic cabinet which is permanent, mobile and inexpensive. The drawers of many sizes and partitioned sections are well suited for storage of medications, tubes, and other items.

Dornette, William H. L., and Hughes, B.H.: "Care of the Teeth during Anesthesia." *Anes. and Analg.* 206, May-June, 1959.

A patient's dental prosthesis may not be immediately apparent, and the patient may be reticent to discuss it or even to admit to having one. If the anesthetist suspects that one might be present, but can neither confirm his suspicion by examination or the patient's admission, he should not hesitate to call the patient's dentist and inquire about the dental work.

The anesthetist is responsible for seeing that all dentures are removed in the operating room. If one is damaged, he should speak frankly and promptly with the patient and his family. Delay only evokes suspicion. Responsibility for repairs is a matter for individual consideration, but if the patient has concealed the presence of a denture or refused to remove one, the anesthetist is relieved of all responsibility.

This article also discusses in detail various types of prostheses, the pressure that teeth and gums can be expected to

withstand, and various technics of instrumentation in the mouth. The structure and the impaction pattern of every patient's mouth are different, and anesthetists are urged to respect this particular individuality as they begin anesthetizing procedures.

Cheek, David B.: "What Does the Surgically Anesthetized Patient Hear?" *Rocky Mt. Med. J.* 57:59, January, 1960.

Maybe too much, the author answers.

The sense of hearing is apparently maintained at the great depths of chemical intoxication that accompany anesthesia, even when all other perceptions and common reflexes are suppressed. Every anesthetized patient should be treated as though he were capable of hearing.

Using hypnosis for recall, the author studied the operative experiences of 212 subjects. One woman became very angry when she recalled that her surgeon had invited an assistant to remove her ovarian cyst.

Another patient who postoperatively had an intense dislike of her surgeon which had not been characteristic of their relationship before surgery recalled that two visiting surgeons had been invited to witness her surgery. She considered this an invasion of her privacy.

Another patient after surgery abused the entire hospital staff, whereas before her operation she had been pleasant and amenable. She recalled that during the operation the surgeon had discussed the severity of her cancer with members of the team, but when he visited her postoperatively, he had denied the existence of any malignancy.

The subconscious mind of the anesthetized patient may also be keenly aware of reassuring suggestions that can be used to favorably influence the course of the postoperative period.

The author has also found patients who, even when unconscious with diabetic coma, concussion, and turpentine intoxication, were able to hear meaningful sounds which they recalled during hypnosis.

The assumption is that the hearing sense is maintained as the last communication with the environment in times of danger.

Chavan, Shankar B., King, John Harry, Jr., and Cummings, Edward J.: "Eye Bank – Procedures for Obtaining, Processing and Sterilizing of Donor Eyes in Neosporin. Part 2." *Bull. Georgetown U. Med. Center* 12:111, January 1959.

Donor eyes must be enucleated in the operating room with full asepsis to prevent transmission of infection to the re-

cipient. As soon as some responsible person has obtained permission for enucleation, all effort should be made to remove the eyes within six to seven hours of death. If the eyelids have been properly closed and the body has been refrigerated, a delay, never to exceed 12 hours, may be tolerated.

In the operating room, the entire eye area is prepared with a detergent germicide and an iodophor tincture. A sterile applicator saturated with a wide-range antibacterial eye solution is used to clean eyelashes. Surgical drapes are applied. The eyelids are opened, and the cornea and conjunctival sac are irrigated with sterile normal saline. Neosporin eye drops are instilled; enucleation is completed without causing facial disfigurement.

It is imperative that the corneal epithelium be protected at all times from drying and ulceration, to minimize the possibilities of infection.

Cultures are taken before the eyes are irrigated generously with sterile normal saline. The enucleated eyes are examined under a slit-lamp microscope and evaluated. Each eye is then immersed (corneal surface upwards) in separate containers of antibacterial ophthalmic solution for 15 minutes.

The most common contaminants in donor eye cultures were *S. aureus,* pneumococcus, *S. hemolyticus,* meningococcus, and *P. aeruginosa.* In 100 cultures, 77 were positive and 23 negative. All organisms were destroyed after 15 minutes immersion in Neosporin. No effect could be noted on the epithelial layer.

After sterilization, each eye is placed on a layer of sterile gauze or cotton saturated with sterile normal saline and placed in a sterile bottle. The bottles are refrigerated at 6° C.

The eyes may be transplanted immediately or stored for future use.

Hand Scrubs and Skin Preparations

By Philip B. Price, M.D.*

Although surgical technics have undergone many improvements there is one inevitably weak link in the chain of procedures which we call "good surgical aseptic technic"—the human skin— which provides some difficult and incompletely solved problems.

I shall try to answer some of the questions related to the subject which have been put to me many times.

Q. Is it possible to sterilize the skin?

A. No. By definition "sterilization" means destruction or elimination of all bacteria. It is not possible to sterilize skin without destroying it.

Q. Is it possible to disinfect the skin?

A. Yes. One can render the skin sufficiently free of bacteria so that it will not cause infection.

Q. Is there any relationship between the current increase in postoperative infections and prevalent operating-room technics?

A. Yes, I think there is. One reason is that there has been an increase in incidence of drug-resistant bacteria. The chief offender is *Staphylococcus aureus*. Certain strains have developed and have become pretty widespread through our hospitals. They are resistant to ordinary antibiotics and are responsible for many infections.

A lot of statistics about infection rates are not quite accurate. This does not mean that people who report them are not honest in their reporting, but rather that there are differences of opinion as to what should be called "infections."

*Dr. Price is Professor of Surgery and Dean of the College of Medicine, University of Utah, Salt Lake City, Utah.

This article is based on a lecture given at the Texas Association of Operating Room Nurses meeting, Houston, Texas, May, 1959.

Any hospital today that is fearlessly self-critical, that is rigid in its criteria, that calls any kind of wound inflammation, even little stitch abscesses or reddening of the incision line, "infections,"—even though they may never break down or produce pus, or sinuses, or abscesses—such a hospital will almost surely report a disturbingly high infection rate.

The situation may be actually worse than these reports indicate due to the short-term hospital stay of today's patients. Many infections come to light after the patients are discharged, are seen only in the doctor's office, and never become part of the hospital's statistics.

High infection rates and present-day technics are also related because of undue reliance upon antibiotics. I know a hospital, a children's hospital, which does primarily clean elective surgery; yet every child receives antibiotics routinely before operations, in the hope that infections will be prevented. The program fails because of the presence of drug-resistant bacteria.

The availability of antibiotics has lulled many people into a false sense of security so that time-honored but troublesome measures to prevent infection are ignored, or are given less attention than they deserve.

On my own service I have tried to prevent the hospital staff, and my associates and assistants, from giving any antibiotics to any patient in connection with an operation, unless there is some definite indication for their employment.

Save antibiotics until they are needed! Find out what the particular infectious organism is, if possible; have the laboratory make appropriate sensitivity tests; then give a suitable antibiotic, in proper dose, for the right length of time, directed specifically at the organism that is at fault. That, to my mind, is the only proper way to use antibiotics.

Air contamination is also related to the incidence of infection. There are many sources of air contamination. Perhaps the chief one is the mouth, nose and pharynx of the people who work in the operating suite. Properly used masks are necessary to prevent contamination from this source.

In spite of efforts to improve masks, the old-fashioned gauze mask probably provides better protection than any other sort, provided it is made and used properly. It should consist of at least eight layers of gauze. It should be worn snugly over the mouth and nose. It should be large enough to cover a wide area of the face around the mouth and nose. Masks which have been used, laundered, sterilized and re-used so

often that they have lost their structure should be discarded.

When a gauze mask has been used too many times, the threads in the mesh become distorted so that there are wide spaces between the threads. This defeats the purpose of the mask, because organisms in expired air pass easily through those spaces.

People have asked why it is that a gauze mask, which does have relatively large interstices between the threads, is able to catch air-borne bacteria that are microscopic in size. The answer is that bacteria which come from the mouth and nose do not float freely in the air. They are collected on droplets of saliva or mucus. It is these droplets that are caught by the absorbent mask.

However – and this is an important point – if one wears a mask too long, it loses much of its effectiveness.

How often one sees an intern or a nurse in the operating suite pull down a mask, let it drop down on the chest, walk around, and then put the same mask back on. That is a mistake.

Actually, if a person participates in a prolonged operation, lasting, let us say, over a couple of hours, he would do well to pause long enough in the midst of the procedure to change masks– for after a couple of hours of use the mask loses effectiveness.

There are other things connected with air contamination. One of the greatest offenders of all is the mop pail, and the dirty mop that is used to clean the operating room.

How often the chore of mopping is unsupervised. It is just left to an ignorant or careless orderly! He goes to his utility room, pulls out a filthy mop and pail, and proceeds to spread infectious bacteria all over the operating-room suite. Dr. Carl Walter has often discussed this, because it is one of his pet peeves.

Clothes also have a role in air contamination. We have a rigid rule in our surgical suite: nobody is allowed in the restricted area, where the operating rooms are located, in street clothes or street shoes. Countless infectious organisms are carried on our clothes all the time.

That is a hard rule to enforce, particularly when the chief surgeons are loath to comply, or when x-ray technicians come to take pictures but don't want to stop long enough to change into operating suits. I don't know any other way to handle this problem, however, except to isolate the operating room from the general traffic of the hospital, and require that *all* personnel change their outer clothes and shoes, and be properly

capped and masked, whenever they enter the restricted operating room area. They must then take off those suits and shoes before they leave the surgical suite. They are not allowed to wander through the hospital in operating-room clothes.

This rule must also be imposed upon all visitors. It may cut down the number of visitors, but perhaps that's a good thing. This policy may not be good for the ego of the surgeon who likes to show off, but it will be a very good thing for the infection rate among patients.

There are other things to consider also, such as too much talking in the operating room. I personally don't believe in the exclusive use of sign language, as some operators do, but I do think that chatter in the operating room by the operating team or by the circulating nurse, visitors, and others is not a good practice and should be kept to a minimum.

One important problem which has arisen in recent years is that of air conditioning. As air comes pouring into the operating room, we try to filter it, and run it through a Precipitron to take out the dust and moisture particles that bacteria cling to. We may be successful in those objectives if the air conditioner is run properly. All too often, however, that responsibility is delegated to the hospital engineer, who knows nothing about bacteriology. He fails to change the filters frequently enough; the ducts are not kept clean. If one will expose culture plates in front of the inlet of the air-conditioning ducts, he can easily determine whether many bacteria are being introduced.

I may seem to have gotten away from skin preparation, but actually the factors I have just discussed all contribute to getting bacteria onto the skin – on the patient's skin and the operator's hands. That is part of our problem.

Finally, there is a relationship between surgical technic and infection rates because ineffective methods are used to disinfect the hands and the surgical field.

Q. Please discuss agents containing hexachlorophene.

A. Hexachlorophene is a substance that was introduced about 10 years ago. It quickly became popular and has now almost displaced other methods of hand and skin preparation.

Here, in my opinion, lies one of the major defects in our modern surgical technic. Actually, hexachlorophene, used properly, is a strong and effective antibacterial agent. But one ought to understand how it works. It is one of the few known antiseptic agents that are not weakened

or neutralized by soap. An effective antiseptic soap has been sought for many years, longer than most of us have lived.

But the search was unsuccessful until hexachlorophene came along. Hexachlorophene is not soluble in water. However, it is soluble in alkali, alcohol, acetone, and a few other substances. There is enough alkali in soap so that the hexachlorophene remains soluble, and therefore active.

Hexachlorophene will kill surface bacteria, but only very slowly. Here it differs from most antiseptic agents that kill bacteria, in a test tube or on the skin, in the course of a few minutes. Hexachlorophene reduces the cutaneous bacterial flora only in the course of several days.

Washing for three or five minutes with hexachlorophene soap does not reduce the bacterial flora of the skin any more rapidly than washing with Ivory soap. That has been shown by large numbers of tests made repeatedly under critical experimental conditions.

If you use hexachlorophene soap, or hexachlorophene in a detergent several times a day, for four or five days, the skin flora will gradually be reduced to a low figure – to as little as five percent of its original size.

Specifically, an operating-room nurse, who scrubs every day and perhaps several times a day, will maintain a relatively small bacterial flora on her hands, especially if she also uses hexachlorophene soap exclusively at home, in the bathroom and at the kitchen sink.

If the intern, the resident, or the surgeon will do the same thing, and use only hexachlorophene soap whenever he washes his hands, at home and in the hospital, he can achieve the same result. It is particularly easy for people like dentists who work all day in the same place and wash their hands frequently.

But the person who scrubs only infrequently, or the one who goes over a weekend without washing with hexachlorophene soap, almost surely comes to the scrub sink in the operating room with a large cutaneous flora. In my opinion, the person who scrubs only occasionally with hexachlorophene soap gets very little benefit from it.

The ordinary bacterial flora of the skin regenerates and re-asserts itself fairly rapidly after any kind of skin preparation, whether it is hexachlorophene soap, ordinary soap, or any antiseptic. It may take only 24 hours for the full flora to be re-established.

Q. Have you gone back to the 10-minute hand scrub?

A. I've never given it up. We've always practiced

it, except that we don't use 10 minutes, but seven minutes as a rule. Seven minutes was chosen because that amount of scrubbing is required to remove all the dirt, grease and oils, and all of the contaminating or transient bacteria from the skin. In the process, about half of the resident flora is removed also.

My staff members are permitted to use Ivory soap, green soap, hexachlorophene soap, or hexachlorophene detergent – whatever they wish – but in any case they have to scrub with brush and running water and one of these agents for at least seven minutes. This scrub is always followed by an alcohol wash.

Q. What about bar soap as opposed to liquid soap?

A. I don't believe it makes a bit of difference; use whichever is more convenient or more economical.

From a bacteriological standpoint you get equal results from the two.

Personally, I like bar soap. It's what we are used to all of our lives; we employ it efficiently, and not wastefully.

Q. Our chief of surgery has requested that we autoclave germicidal soap to be used for skin preps and hand scrubs. Is this necessary?

A. No. Germicidal soaps, and even ordinary soaps, tend to sterilize themselves. If an ordinary cake of soap, such as you can buy on the open market, has been rinsed off and placed in a clean soap dish, you will find it difficult to culture any bacteria off the surface. The concentrated soap in itself seems to be able to destroy bacteria.

Q. What type of brush do you prefer for hand scrubs? Are the brushes wrapped separately for autoclaving, or are they in a metal container?

A. The type of brush used is important. Some hospital administrators like to buy cheap brushes in the interest of economy. Actually, that is false economy because in cheap brushes the bristles break or get mashed down. They are apt to be so harsh initially that they injure the skin, but soon become too soft to be effective. Cheap brushes have to be replaced frequently.

The best brushes, in my opinion, are those with nylon bristles. Pig-bristle brushes are good, but they're not easy to get nowadays, since most of the bristles came from China.

Nylon bristles set in a plastic-backed brush last well, but they ought to be of good quality. The ends of the bristles should not be cut off so sharply that they injure the skin; and they should not be too coarse and hard. Nylon brushes stand repeated sterilization well and consequently last a

long time. We use them exclusively in my service.

I don't think it matters too much whether brushes are sterilized in separate wrappers or whether they are put in a metal container. Metal containers are convenient to use and are easy on the brushes. If brushes are wrapped too tightly for sterilization, they may be ruined because the bristles are mashed down.

Q. What are the relative values of skin disinfectants?

A. This is not an easy question to answer categorically, because every skin disinfectant has its peculiar advantages and its disadvantages. I've already mentioned hexachlorophene; so I'll discuss some others briefly.

Soap – Some people consider soap a good skin disinfectant. That is not so. It is simply a good cleansing agent. It takes off dirt, but it does not take off cutaneous bacteria to the same degree. It will take off contaminating bacteria, the so-called transients that are loosely attached to the skin, along with the dirt and grease, but it is ineffective against the resident flora.

Alcohol – Is perhaps the most popular of all skin antiseptics – and deservedly so. The best preparation to use, in my opinion, is ethyl alcohol 70 percent by weight (approximately 80 percent by volume). If applied for a proper length of time, with some friction such as one can obtain with use of a piece of gauze or a wash cloth, it is an extremely effective disinfectant agent for skin.

It is very innocuous on skin. Unless it has been adulterated by some harmful denaturing agent – and one doesn't usually find that in hospital supplies of alcohol – 70 percent alcohol doesn't injure even delicate skin, and very few people are sensitive or allergic to it. One can use it repeatedly on the same area. In the strength mentioned it doesn't defat the skin, and I've never found any person whose cutaneous bacterial flora was resistant to alcohol.

So I put ethyl alcohol right at the top of the list of skin antiseptics.

Isopropyl alcohol – Is just about as good, or even in some ways a little bit better, than ethyl alcohol. It has the advantage of being non-potable; hence, no federal tax is imposed, and it can be bought with less legal difficulty. So it turns out to be just as cheap or perhaps a little cheaper than ethyl alcohol.

Isopropyl alcohol is a powerful antibacterial agent; the more concentrated the solution the more effective it is. That is not true of ethyl alcohol, of which 70 percent by weight seems to be the optimum strength. A disadvantage of isopropyl alcohol is that it is a relatively good fat solvent,

whereas ethyl alcohol is not. Hence, isopropyl alcohol tends to defat the skin, taking out some of the natural lipids. It is all right for single applications or infrequent use on patients, but is not good for the operator's hands. Skin washed repeatedly with isopropyl alcohol becomes dry and flaky, which encourages subsequent development of a larger bacterial flora.

Quaternary ammonium compounds (typified by Zephiran) are good antiseptic agents, but they have their pitfalls. The chief one is that Zephiran is neutralized by soap. If one wants to get full value from that agent, one has to be sure that all the soap has been removed from the skin. You can't remove soap from skin simply by rinsing with water. If you want to prove this to yourself, use some scented soap and then rinse your hands off. You will find that the odor remains, and will remain a long time.

We all have thin films of soap on our skin, left over from previous hand-washes or baths. The soap on your skin and on my skin right now is enough to neutralize Zephiran. This is less true with tincture of Zephiran than with aqueous Zephiran. The only way I know to ensure antiseptic action is to remove all the soap.

How can you do that? Use a good soap solvent. The best one I know is a 50 percent solution of ethyl alcohol, although 70 percent will do.

Mercurials – are agents which have passed out of fashion – rightly so, because they're not very good. That includes all mercurials, as far as I am concerned – the inorganic compounds, such as mercuric chloride and mercuric iodide, and the organic ones such as Mercurochrome, Metaphen, and Mercresin. None is very effective as a skin antiseptic.

Iodine – historically, is one of the oldest antiseptics known. Its use has been largely discontinued. That is unfortunate because iodine is still one of the best skin-disinfecting agents available. I don't recommend the preparations that are ordinarily provided, however. The old USP 7 percent tincture of iodine was too strong. It was hard to wash off with alcohol, and it tended to burn the skin, but it was a powerful antiseptic agent.

The new USP "iodine tincture" is less harmful. The best preparation I know of, however, can be made up by the hospital pharmacist: 1% or 2% iodine in 70% (by weight) alcohol. I don't think it matters whether or not sodium iodide is included. The two percent solution is slightly more antiseptic, but some people may prefer one percent, thinking that it might be less irritating to the skin. However, very few people are sensitive to iodine at that strength. These preparations

spread smoothly, dry slowly, and are very effective bacteriologically.

A new agent, which has unusually good antibacterial effects, is "Acrizane." Formula: 9-para hexyl oxyphenol-9-chloro-10-methyl acridine. It can be prepared in aqueous solution or as a tincture; it is not irritating to the skin. Its chief disadvantage is that it tends to stain everything—bedclothes, dressings and hands. The color is hard to remove completely. Hospital administrators might dislike it for that reason.

The first figure illustrates comparatively the effectiveness of some of these antiseptic agents when each of them is applied for exactly two minutes. The longer a surface antiseptic is used, the greater its effect. There is no such thing as instantaneous skin disinfection. It always takes time. The downward slope of the lines in Figure 1 represents the rapidity of action and effectiveness of the skin antiseptics indicated.

In each of these tests, the bacterial flora found on the skin just before the antiseptic was applied was considered to be 100 percent. Zero would indicate complete sterilization of the skin.

The topmost line shows what soap and water accomplishes. Obviously, it is not very effective in reducing the bacterial flora, however well it may clean the skin grossly.

The next line shows that aqueous Merthiolate, 1 to 1,000, doesn't accomplish very much either.

The next line, tincture of Merthiolate, is slightly more efficacious. Next, aqueous Zephiran. In that test, the soap had first been removed thoroughly from the skin surface.

Most of these tinctures—tincture of Merthiolate, tincture of Zephiran, and so on—are prepared in a mixture of 50 percent alcohol—10 percent acetone. This solvent in itself is more effective than the mercurial tinctures.

The next line shows tincture of Zephiran. It is somewhat more effective. Used for two minutes, on soap-free skin, it will reduce the original bacterial flora, however large or small, to about 50 percent of its original size.

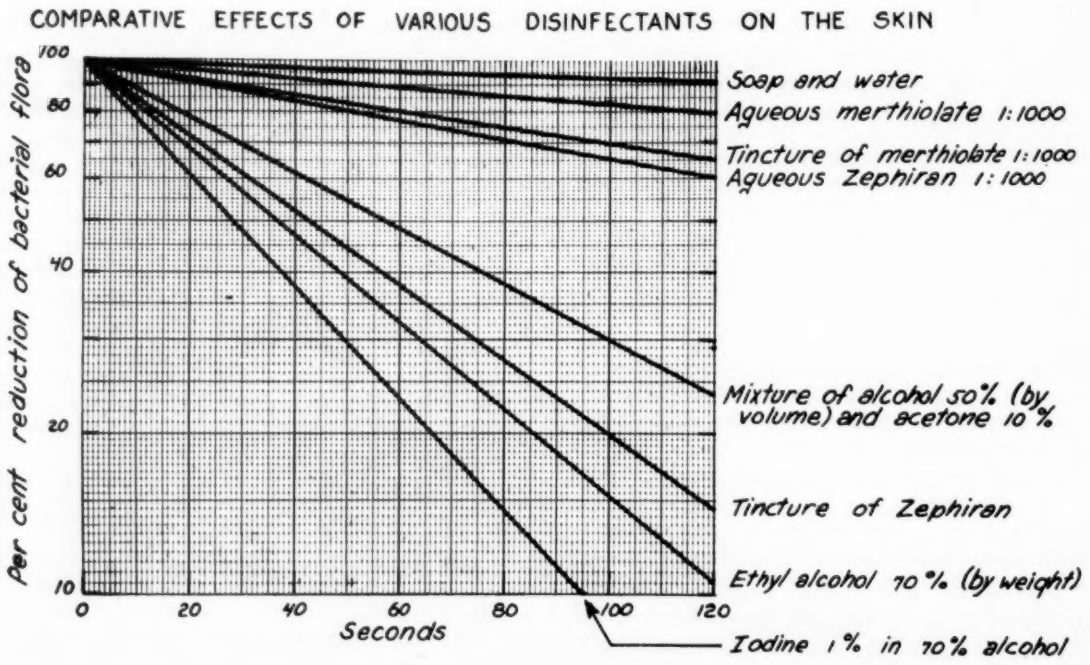
The next line is 70 percent ethyl alcohol which brings the flora down even lower, to about 20 percent of its original size in two minutes.

The last line is one percent iodine in 70 percent ethyl alcohol. That brings the bacterial flora down even lower. A two percent solution would be still better.

Acrizane will produce a curve similar to that of one percent iodine.

Q. Will you describe in detail your method for a hand scrub for either a nurse or a surgeon.

Figure 1


COMPARATIVE EFFECTS OF VARIOUS DISINFECTANTS ON THE SKIN
Per cent reduction of bacterial flora
100
80
60
40
20
10
0
20
40
60
80
100
120
Seconds
Soap and water
Aqueous merthiolate 1:1000
Tincture of merthiolate 1:1000
Aqueous Zephiran 1:1000
Mixture of alcohol 50% (by volume) and acetone 10%
Tincture of Zephiran
Ethyl alcohol 70% (by weight)
Iodine 1% in 70% alcohol

A. First, the nails should be trimmed and be cleaned grossly with a nail file. That can be done at home or in the operating room before the regular hand scrub is started. I don't think there's any virtue in scrubbing half the prescribed time, dropping out to do the nails, and then finishing the scrub. Nor do I think that there is any merit in using orangewood sticks instead of an ordinary metal nail file.

The person should then scrub for at least seven minutes by the clock. The time should be evenly divided over every part of the hands and the arms to above the elbows.

The soap should be rinsed off, and the hands and arms dried with a sterile towel. That removes all the water and any residual soap-suds on the hands. The person then washes for a moment in a basin of ordinary 95 percent ethyl alcohol, to take off any remaining water that's on the skin, so that the 70 percent alcohol to be used later will have full effect. The operator then washes in a basin of 70 percent ethyl alcohol for three minutes by the clock, all the while rubbing the surface of the hands, arms, fingertips and between the fingers with a sterile wash cloth, or a piece of gauze.

This alcohol solution should be properly prepared so that it will have maximum effect. I don't care if it's a little stronger than 70 percent (by weight), but it should be no weaker. Hands are dried before the alcohol wash so as to prevent carrying water from the skin into the alcohol. That would dilute the alcohol.

Another reason for the first dip in 95 percent alcohol is the peculiar property of evaporation of alcohol. Alcohol solutions evaporate in two fractions. One fraction is the water content; the other is the (95 percent) alcohol content.

The alcohol fraction goes off more rapidly than the water fraction; so, if a basin of 70 percent alcohol is left out in a room for a few hours, it will no longer be 70 percent but a weaker solution, because the alcohol fraction has gone off rapidly and left the water fraction behind.

The small amount of 95 percent alcohol brought into this second basin by the operator's hands from the first basin of alcohol is depended upon to keep up the strength and counteract the effects of evaporation.

After the person has washed in the 70 percent alcohol for three minutes, he dries his hands, powders them, and puts on gown and gloves.

Q. Is it necessary to go through a full hand preparation for minor surgical procedures, such as biopsy, cystoscopies, spinal punctures, etc.?

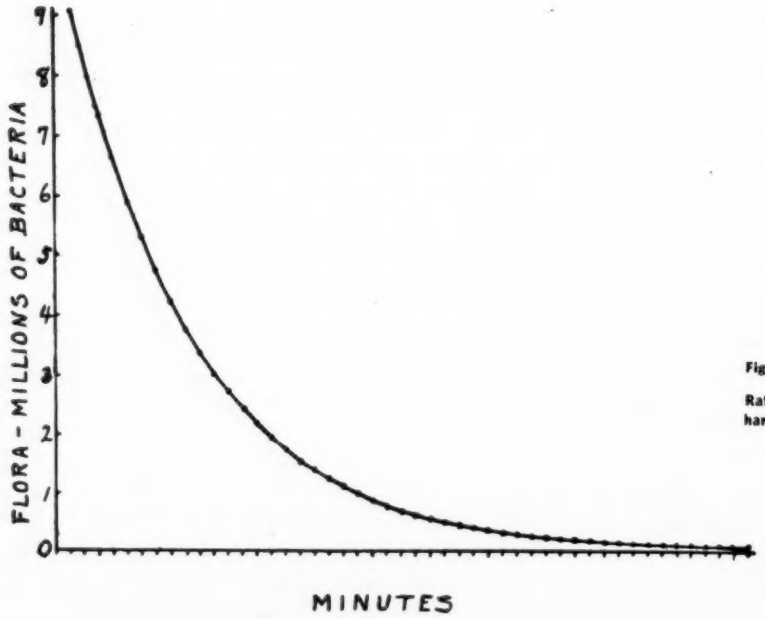


Figure 2.

Rate of reduction of the bacterial flora of hands and arms by scrubbing.

A. No, I really don't think it is. We have in our operating room a "short scrub" method for minor procedures. It consists of scrubbing for three minutes, with either ordinary soap or hexachlorophene soap, drying the hands, and washing for one full minute in 70 percent ethyl alcohol. This is much less effective bacteriologically than the full scrub, already described. Frankly, it is a concession to operators who are unwilling to go through the long procedure for these minor procedures. Even so, it is superior to the prevalent three-minute scrub with hexachlorophene soap.

Q. Why is so much emphasis placed on the length of time spent in scrubbing?

A. Figure 2 shows the rate at which the bacterial flora of the skin is reduced by scrubbing. The straight line on the bottom indicates the passage of time in minutes. This particular chart represents the effect on my own flora of scrubbing for about 30 minutes.

Actually, a person can't scrub that long vigorously without hurting the skin to some extent. However, it is clear that if he scrubs only three minutes the flora is reduced only a relatively small amount; that if he scrubs for 10 minutes he will reduce his cutaneous flora considerably more; that if he scrubs for 15 minutes, he gets more effect yet. That is why we believe in watching the clock when scrubbing; why scrubbing alone will not suffice; and why we insist, at least on my service, on the subsequent use of alcohol which is bacteriologically much more effective than scrubbing.

Q. Should caps and masks be autoclaved?

A. Yes.

Q. What about the use of Dial, Zest, etc., at home instead of pHisoHex?

A. There are a number of these antiseptic soaps available on the market. They can be quite effective. I know Dr. Walter feels strongly, and I agree with him, that a hospital would do very well to use hexachlorophene soap throughout the institution, even in the laundry.

Q. What about patients bathing in advance for several days before surgery with pHisoHex, or Dial, or some such preparation?

A. That's excellent! If you have an elective operation, I don't know of any better preparation for it. That is particularly true in areas that are hard to clean, such as the perineum, the hand, or the foot. These patients will come to the operating room with a skin that has a low bacterial flora, and the chances of subsequent infection are greatly reduced.

Q. What is a good vaginal prep?

A. It is necessary to use a procedure that will not hurt the delicate mucous membrane. Fortunately, the bacterial flora of the vagina is comparatively small (unless there's a bad infection present), and is easily reduced. Ordinary washing with soap and water will accomplish a good deal, because the bacteria in the healthy vagina are all strictly surface organisms.

I can recommend either of the following methods:

If it is an elective case and if the patient is cooperative and intelligent, have her use hexachlorophene soap for a few days ahead of time in the form of baths and douches.

But if the patient comes in needing immediate preparation for surgery, a wash with soap and water, a rinse with a weak solution (say 50 per cent) of alcohol to take off all the soap, and the use of aqueous Zephiran is about the best one can do.

Q. How can you teach an older and supposedly wiser surgeon to cover his nose when wearing his mask?

A. That is a matter of pedagogy. Unfortunately, older surgeons are not always teachable. But an influential and tactful nurse who is quietly insistent can accomplish a great deal. It is true that quiet breathing through the nose is not very dangerous – but nobody breathes quietly through the nose! You clear your throat, or you cough, or you say something, and out comes a burst of particles of moisture from the nose containing a lot of bacteria.

Some of the worst bacterial offenders are harbored in the sinuses and in the nasal pharynx. They may be dangerous. Perhaps you could induce your senior surgeon to wear a mask over his mouth but not over his nose, and then talk into an open petri dish containing culture media. You could thus demonstrate to him how many bacteria do come out of the nose when it is not masked.

Q. Has an electric hand dryer any use in the scrub room?

A. I don't think it has any advantage over a towel. On the other hand, it is expensive and tends to blow particles of moisture around.

Q. What hand scrub should be done between cases?

A. You should remember that under rubber gloves the environment is very favorable to multiplication of bacteria.

After a person has worn his gloves for three or four hours, his bacterial flora may be as great or greater when he takes off his gloves than it was before he started scrubbing, and whatever pathogenic bacteria that may have been present participate in that increase.

However, when you take off your gloves, your hands are not dirty or greasy. So I can see no point in going through a routine scrub. Simply rinse the hands under running water, using a little soap to remove sweat and any powder that may be present, dry the hands with a sterile towel, and then go through the alcohol solutions.

If you had been engaged in a short operation and had not been wearing gloves continuously for a long time, you need not spend a full three minutes in alcohol. A useful rule-of-thumb is to wash in alcohol one minute for each hour that gloves have been worn continuously; that is, if you've been in a three-hour operation you wash in alcohol for three minutes; if you've been in a one-hour operation, you wash in alcohol for one minute.

Exceptions are:

(1) If a glove has been torn or punctured so that blood is found on the ungloved hands or fingers, then the regular scrub is indicated.

(2) If the surgery has involved a known infectious case, the full scrub is indicated because there may be an undetected puncture in the glove.

Q. What is your routine preparation for the operative site?

"I've just added a Willkie button to my collection. I now have six coins, three bottle caps, two eye teeth, one key, two rings, one nail, four paper clips, two marbles, one safety pin, and a contact lens."

A. I recommend hexachlorophene only if the operation is elective and the patient can wash with it repeatedly for several days ahead.

We don't wash the area with soap and water in the operating room as a rule. If it's necessary to shave the part, soap lather may be necessary.

I don't believe in elaborate routine ward preparations. To clean an area, apply antiseptics, and then wrap that area in sterile towels or dressings the day before or two or three days before the operation is, to my mind, bacteriologically useless and psychologically bad for the patient.

All that is required on the ward is that the patient be washed or bathed the evening before, or on the morning of the operation.

Shaving is an important detail. A safety razor with a new blade should be used – without scratching the skin. A patient who comes to the operating room with scratches from the shave probably has an abnormally large bacterial flora containing pathogens; thus the chances of infection will have multiplied.

In the operating room, one good way to prepare the field for operation is to wash it with alcohol and then apply iodine. Excess iodine is removed with another alcohol wash. A routine which my staff likes, and of which I approve, consists of washing alternately with 70 per cent alcohol (or 99 per cent isopropyl alcohol) and tincture of Zephiran, using each three times.

We alternate in that fashion (1) because the alcohol, itself an effective antiseptic, takes off residual soap so the Zephiran can act; and (2) because the regimen necessarily takes three or four minutes of time.

Disinfection is a chemical reaction between the chemical agent and the bacterial cells. Like all chemical reactions, it requires a certain amount of time for completion. It can't be done immediately. Even an impatient surgeon can't hurry it.

Ether was once used routinely in many operating rooms as a step in skin disinfection, but it had no merit. It is not a good cleansing agent; it doesn't have any bacteriological effect; it increases the explosion hazard; it is uncomfortable for the patient; it has an unpleasant smell, and it is expensive.

Q. What is your opinion of the adherent plastic drape?

A. It has real advantages because it does exclude the skin flora. But here again, as so often happens, there are disadvantages along with the advantages. Underneath any plastic drape you will have rapid multiplication of bacteria.

In this connection, I should explain I have a certain skin flora on my skin. It's characteristic for my particular physique. You may have another one; and the patient will have still another one. The flora may be larger in some people than in others. I happen to have a small one. I don't know why; maybe it's because the pH of my skin is different.

What keeps the size of any skin bacterial flora at that level? I don't know; nobody knows. But my flora can be changed by abnormal conditions. If my skin is covered with rubber gloves or with a plastic covering its flora soon grows to enormous size!

Now that will happen under a plastic covering. If the plastic is then punctured or cut, or is rubbed off, those bacteria will escape into the wound.

Also, in my experience, some people tend to get an unhealthy skin after wearing a plastic drape for some time.

Q. Do you think skin towels are advantageous?

A. I think the more one can exclude the skin the better. One should not be fooled into thinking that wet skin towels offer any protection, however. Bacteria from the skin pass readily through wet skin towels or drapes.

Skin towels should be brought up close to the wound margin. One should be careful in the use of towel clips. They are vicious things. They bruise or make nasty little holes in the skin; they are uncomfortable for patients; yet something of the sort is necessary. I like to sew the skin towels, not to the skin margin itself, but to the fascia layer just underneath the skin. But that takes time, so it isn't always done.

Q. Do you require all surgeons and personnel to have periodic throat cultures? If so, how often?

A. No, we don't. I don't think it's worth the time. We all have pathogenic bacteria in our mouths and throats. If we don't today, we will tomorrow, because all sorts of things go in our mouths. Every time we eat or drink, bacteria are introduced.

However, if you have a series of infections in "clean cases," and particularly if your bacteriologist finds that they are due to some particular organism, then perhaps you will need to make routine cultures to find the offending carrier.

I have heard Dr. Carl Walter say that culturing the clothing is more informative than culturing the throats, because whatever we get in our throats will get on our clothing. Culturing the clothing, particularly the underclothing of hospital person-

nel, may pick up the organism at fault and the carrier more easily than culturing throats.

Q. Do you think nurses should bathe at home in soap containing hexachlorophene?

A. That would be a good idea for all of us.

Q. Do you think that patients having cervical laminectomies should have a hair shampoo before surgery?

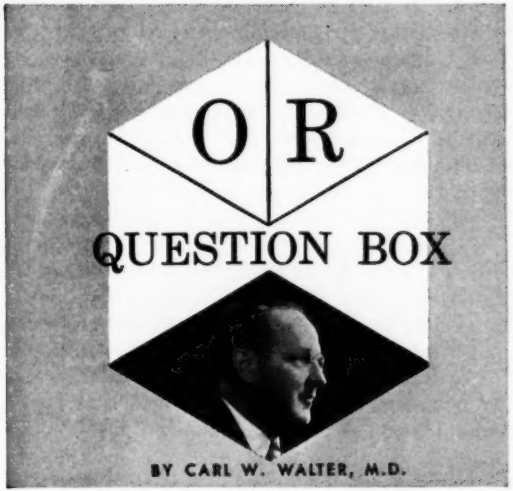
A. If this is possible, of course it should be done. The scalp and its hair are among the dirtiest parts of our body. Next to the mouth, the rectum, and fingernails, the scalp is the least clean area. It collects dirt easily, and the dirt is difficult to remove. So a shampoo is a good thing. And here one can use hexachlorophene soap to good advantage.

Pony Tails Intact in New Surgery Technic

Women who undergo brain surgery no longer have to leave the hospital with shaved heads, according to a neurosurgeon who uses a pony tail-hair spray technic.

Jonathan M. Williams, M.D., of Washington, D. C., has his patients wash their hair with a detergent-hexachlorophene shampoo several times during three or four days prior to surgery.

Just before surgery, the hair is parted along the lines of the incision and combed into small pony tails. The nonlacquer hair spray then applied kills germs because of its high alcohol content.



Assisted by Dorothy W. Errera, R.N.

Q. Is a hot-air drier necessary when using the lubricating germicide after scrubbing?

A. An air drier is necessary because toweling will remove the cetyl alcohol from the skin.

Q. Can an ordinary soap dispenser be used for the lubricating germicide?

A. Be sure the dispenser is one that will not be destroyed by the isopropyl alcohol.

Q. What do you recommend for preparing the skin for eye surgery?

A. The face in most individuals is clean. Scrubbing with sponges moistened with 1:750 aqueous quaternary ammonium compound is adequate and non-irritating.

Q. One of our surgeons has his patients catheterized every six to eight hours and is complaining about frequent cases of cystitis. At present we are using green soap and sterile water on our cleaning trays. Our urologist has suggested we use a hexachlorophene soap. Cultures on our catheters have been consistently negative. What is your opinion of this situation?

A. Under the best of circumstances, a patient being catheterized every six hours is likely to develop cystitis. An indwelling catheter is less traumatic to patients and offers more resistance to infection provided the catheter and drainage equipment are handled aseptically.

Green soap is a poor detergent and has no bactericidal action and has little place in modern hospital practice. Soaps or detergents containing hexachlorophene are not one-shot germicides, that is to say, they are germicidal only when used over a period of time. If you persist in repeated cath-

eterizations, you will achieve the cumulative germicidal effect that accompanies routine use of these agents. Providing the patient with the same agent for routine perineal care will also enhance the effect.

For single-shot preparation of the labia and meatus, sponges wet with a 1:750 solution of an aqueous quaternary ammonium compound will provide detergency and disinfection. Use several sponges and use each sponge with a single wiping motion.

It may well be that skin of the hands of personnel accomplishing the catheterizations merits more bacteriological survey than your sterilizing technics.

Q. Is it acceptable for scrub nurses in delivery to wear plain wedding bands while scrubbing?

A. You have only to remove a few wedding bands at randon and examine the collections of dirt, epithelium and grease to be convinced that they represent potential sources of contamination. The nurse scrubbing for obstetrical work has no less a bacteriological problem than the nurse scrubbing for surgery and no less a responsibility for the patient whose recovery may depend on attention to these minutae of aseptic technic.

Wedding bands and watch straps on nursery personnel are similarly potential sources of trouble.

Q. Do you think that electric dryers might harbor bacteria as well as cause increased circulation of bacteria when the fan is in motion?

A. In a dirty environment, the fan would certainly stir up dust from the floor but this objection is defeated if good housekeeping is routine. It is unlikely that the dryer itself would support bacteria because of the high temperatures of the heating coils.

Q. What is a "proper" soap for handwashing?

A. Any soap or detergent which is formulated with a germicide is suitable for skin cleansing. Most depend on the use of hexachlorophene as the bacteriostatic agent to suppress bacteria growing on the skin. This material (G-11) is not effective against gram-negative bacteria, and often soaps and detergents containing G-11 are found heavily contaminated with these organisms.

Liquid soaps and detergents are to be preferred because they are less prone to contamination than bar soaps. Soaps containing tetramethylthiuram disulphide in addition to hexachlorophene are superior because they are practically self-disinfecting.

Q. Do you think there is any difference in results if sponges are kept soaking in 70 percent alcohol or wet with alcohol from a bottle just before the skin is cleaned for an injection?

A. Cotton sponges moistened with alcohol are effective for disinfecting the skin site of an injec-

tion. They can either be immersed in alcohol or wet at the time of use with the solution in a squeeze bottle. The latter technic may be more wasteful, and, unless care is taken, the sponge may be only superficially moistened.

When this technic is used, sponges should be sterilized before immersion in alcohol or packaging in canisters. They should be large enough to provide a good cleaning surface. Wisps of cotton used in many hospitals for cleaning the skin for injection or vein puncture are useless. Transfer forceps should be used for removing sponges from stock containers so that residual supplies are not loaded with bacteria from fingers. Containers for alcohol should have snug closures so that evaporation is minimized and germicidal concentration remains bactericidal.

Q. Shouldn't surgeons remove their gloves between cases? A full scrub between cases is certainly to be preferred to having them answer telephones and do other things wearing dirty gloves.

A. The habit of idling between cases in soiled gloves and gowns is esthetically unappealing and bacteriologically unsound. In modern practice, the daily and consistent use of suppressants for cleaning the skin substantially reduces the bacteria so that the individual who is free of gastrointestinal infection or upper respiratory disease can safely disinfect his hands between cases with a simple wash using the same germicidal detergent or soap. The bacteria picked up in casual contacts, exclusive of those associated with disease, are usually transients which are easily removed by washing and rinsing.

A broad-spectrum, single-shot germicide is applied to the skin both after the initial scrub and after subsequent cleaning between cases, to destroy surface bacteria. This germicide can also contain bacteriostats to aid in suppressing the growth of bacteria deep in hair follicles and sweat glands.

Q. In all operating rooms I have worked in, we always have to wait at least 12 to 18 hours before using catgut suture tubes after jars have been refilled. This is also the routine for knife blades and I am wondering if we must wait the 18 hours when so many other things like dematome blades are only soaked 20 minutes using the same or even less powerful germicides?

A. If you are interested in total destruction of bacteria, you wait the 18 hours.

If you use an improved germicide containing hexachlorophene, time can be cut to 3 hours.

If you are interested in patient and personnel safety, you abandon chemical disinfection entirely except for use with new, unused, non-heat-stable bits of equipment.

If you are interested in economy and best use of your valuable time, you recognize there is little justification in avoiding the use of modern, prepackaged, pre-sterilized blades and suture materials offered by many manufacturers.

Q. Do solutions of quaternary ammonium compounds used in glove basins have to be steam-sterilized?

A. Quaternary ammonium compounds should not be used with tap water because the mineral content of the latter interferes with bactericidal action. Solutions made with fresh distilled water need not be sterilized unless the ultimate solution is more dilute than 0.1 percent (1:1000).

All glassware – flasks, graduates, etc. – must be scrupulously clean to prevent elution of the quaternary ammonium compound on the dirty surface of the glass. This would result in a more dilute solution than originally sought. In my opinion, 1:5000 is too dilute for use in glove basins. I could suggest 1:750 for better action.

Q. What germicide do you recommend for soaking contaminated instruments?

A. Chemical disinfection of contaminated instruments is notoriously unreliable and has no effect on the virus of homologous serum jaundice. If an instrument washer-sterilizer is not available, use boiling water with a non-foaming detergent added to leach out soil.

Q. Why do you recommend non-ionizing detergents?

A. Calcium and magnesium salts are two components present in ordinary tap water. If a cationic or an anionic detergent is added, an insoluble complex is formed, and the result is crust, curd or scum. If, however, a non-iodizing detergent is used, the calcium and magnesium combine with the detergent to form a soluble compound that remains in solution and can be rinsed away. Hence no film, curd or scum is deposited.

Q. Is there any contraindication to using iodophors where PBI's are done?

A. There is not enough sublimation of iodine from an iodophor solution to affect these tests.

Q. We are considering sterilizing spinal ampoules in the ethylene-oxide sterilizer. Is there any danger that the ethylene oxide may cause a chemical change in the drugs if the ampoule has an undetected crack?

A. The negative pressure cycle of the ethylene-oxide sterilizer would empty defective ampoules; hence, there need be no concern for chemical action between the gas and the ampoule contents. Most anesthesia drugs withstand sterilization in the steam sterilizer, and there is little purpose to using the more expensive and time-consuming ethylene oxide technic.

Q. Will steam penetrate a tightly rolled gauze bandage?

A. Steam will penetrate a roll of bandage if it is removed from its paper wrapper before sterilization.

Q. Do you recommend cleaning the sterilizer drain line with trisodium phosphate?

A. If solutions and oils have been sterilized in the sterilizer and have overflowed to the drain line, trisodium phosphate will be very helpful in cleaning the line. If, however, nothing but clean steam has been through the line, the detergent is not needed.

Q. We cannot see that an instrument lubricant that actually coats an instrument with an impermeable layer will allow that instrument to be thoroughly sterilized. What, for instance, happens if that layer is broken during the time the instrument is used? Isn't the surface under the layer then unsterile?

A. Silicone lubricants that protect instruments against atmospheric corrosion and aid in lubrication during use can indeed wall in dry spores to the point where moist heat does not penetrate in sufficient quantity to be microbocidal in the usual period of exposure in the steam sterilizer.

The chief problem in the lubrication of surgical instruments lies in adequate cleaning. Instruments become stiff because blood and pus accumulate in the box. As this is heated in a steam sterilizer, protein is baked on the surface; this becomes stony hard and causes an interference fit. Lubrication eases this problem temporarily but, ultimately, the instrument stiffens again. Thorough cleaning is the only answer to instrument maintenance. Fortunately, ultrasonic cleaners accomplish this readily. Mechanical burnishers and mechanical methods for cleaning instruments are also effective when an adequate detergent is used.

Q. We have been asked to sterilize cardiac and orthopedic instruments twice at 250°F., for 30 minutes each time. This, of course, is time-consuming, and we wonder whether the request is reasonable?

A. There is no justification for a prolonged sterilizing period for any particular group of instruments. The bacterial population is the same; the spores are the same. Enforcing this technic would be a display of ignorance and waste. If instruments are free of oil and grease and boxes and locks are loose, they will be sterile after 13 minutes exposure to saturated steam at 250° F. If they are not clean or if locks are tightly set, sterilization will be uncertain.

Steam sterilization is dependent on steam being able to contact and wet all surfaces. Anything that interferes with this contact interferes with steriliza-

tion. Steam will not penetrate oil or grease, nor can it get between tightly apposed surfaces – hence the warning that instruments sterilized in steam be clean and unlocked.

Q. If we are careful of how we handle contaminated instruments, can we put them in the ultrasonic cleaner before they are put in the instrument washer-sterilizer? We feel our instruments would be cleaner with this technic.

A. The ultrasonic cleaner will ultimately become heavily contaminated, and it cannot be disinfected. Contaminated instruments should be terminally sterilized before they are handled or put in the ultrasonic cleaner. The objection that the instrument washer-sterilizer does not remove soil can usually be traced to three errors: (1) the sterilizer must be connected to the water supply so that it fills with *cold* water; (2) a detergent-water softener combination must be worked out for the local water supply, and (3) instruments must be unlocked so that cold water reaches all surfaces.

Q. We have been keeping our instruments together with rubber bands during sterilization. One of our nurses recently attended your institute and came back and told us we must stop this. Can you explain?

A. Rubber bands on instruments guarantee unsterile instruments for the aseptic field. To be an effective bactericide, steam must have access to all surfaces being sterilized so that it heats and wets and sterilizes. In this instance, the rubber bands would protect bacteria from exposure to steam. When the bands are removed at the time of operation, viable bacteria may be freed into the wound.

Q. What will remove the crust inside the instrument washer-sterilizer?

A. First, try cleaning with a stainless steel scouring pad and a little acetic acid. If this doesn't work, make a solution of equal parts of hydrochloric acid and cold water. *Be sure to pour the acid in the water.* Wear rubber gloves and use a stainless steel scouring pad with the solution to mechanically and chemically break up the crust.

Q. We are in the midst of a dispute regarding sterilization of instruments in the high-speed autoclave. Heretofore, we have sterilized a "few" instruments (four or five) for three minutes at 270° F. More than a few—a whole set, for instance —we have sterilized for six minutes. These are unwrapped, and the reason for the longer sterilization period is the need for proper penetration.

A. When instruments are sterilized in the steam sterilizer unwrapped, there is no problem of penetration. Heating is by direct contact between instrument and steam. Heat is also conducted from instrument to instrument very quickly, and it takes but a few seconds for the load to reach

sterilizing temperature. Hence, there is no need to adjust sterilizing times for the number of instruments included in a load. For one or a hundred, the thermal death time is 13 minutes at 250° F. exhaust-line temperature or two minutes at 270° F. exhaust-line temperature.

BUT if instruments are sterilized in a muslin wrapper, time must be allowed for steam to penetrate the wrapper. Seven minutes at 270° F. is adequate. The number of instruments being sterilized is not the subject for concern. The quality of the wrapper is the determining factor in penetrating time.

In either instance, instruments are sterilized unlocked and loosely stacked, so that there are no tightly apposed surfaces to inhibit direct contact by steam.

Q. Is it correct to place soiled instruments directly into a washer-sterilizer, provided that a clean nurse prepares the sterilizer?

A. This is the exact purpose for which the instrument was designed. Contaminated instruments are collected into buckets or trays by the scrub nurse. Latches are released; cutting edges are protected from contact with other instruments, and the trays are loaded in the sterilizer. Detergent and water softener are added; the sterilizer is closed; *cold* water is run in to dissolve blood and protein soil. The steam is turned on. In approximately eight minutes, the instruments are clean, sterile and ready for use in another case. This cycle includes two minutes exposure to a temperature of 270°F.

Q. How do you care for syringes used for giving nitrogen mustard? We have a patient who will be treated at monthly intervals. Should we discard the syringes? It would be an extravagant use of 20 cc. syringes if we do.

A. Nitrogen mustard irritates mucous membranes and is particularly harmful to the eyes. If there is accidental contact with the drug, the skin is washed with large amounts of soap and water. If any solution is splashed into the eyes, the latter must be rinsed with generous amounts of physiological saline.

The person administering nitrogen mustard always wears rubber gloves. At the end of the infusion while that person is still in gloves, he washes all the equipment with large quantities of warm water. The contaminated syringe and needle are then dropped into a basin of 1:1000 sodium hypochlorite and stay immersed for at least one hour before they are handled by anyone not protected by rubber gloves. The infusion set, after it is washed with water, is discarded in the trash can. The ampules containing the drug are immersed in the sodium hypochlorite for one hour before being discarded.

Q. Can shielded syringes used for isotope therapy be sterilized?

A. Most lead-shielded syringes can be disassembled for sterilization. If there is any internal lighting arrangement, this must be removed, unless the manufacturer's specifications include a heat-stable light carrier. The Beta shields used on glass syringes can be autoclaved.

In any hospital employing isotope therapy, there must be a radiological safety officer and it is for this person to decide what constitutes safe handling for equipment. Contaminated syringes and needles are usually dropped into a bucket of detergent and kept immersed until this officer determines if they are returned to use or held for radioactive decay.

Q. In our anesthesia department we have been autoclaving syringes with plungers and barrels separated. Several hospitals in our area autoclave them together. Can these syringes be considered sterile? We would like to autoclave assembled syringes with plastic covers on the tips. Is this practical?

A. Destruction of microbial life in the steam sterilizer depends on all surfaces being exposed to heat and moisture for a period sufficient to destroy the most resistant organism. If a syringe is dry when assembled and autoclaved, the inner barrel and plunger are exposed to *dry* heat only — and at 250° F., the temperature at which steam sterilizers operate, four hours exposure is needed.

If, however, the plunger is moistened with distilled water immediately before assembly and sterilization, the film of moisture necessary for steam sterilization is provided in the space between plunger and barrel, and sterilization is accomplished in the 30-minute cycle at 250° F.

However, this residual moisture in the syringe is a potential disadvantage, because during sterilization, the water leaches out alkali from the ground glass syringe, and subsequently this alkali may be incompatible with certain drugs.

Bursting fractures are common in syringes sterilized assembled in the steam sterilizer because cooling is uneven. The barrel will cool faster than the plunger and shrink down on the latter, and the result is a crack or an open frank break.

Assembled syringes are best sterilized in dry heat at 320° F. for one hour or in dry heat at 250° F. for four hours. The ordinary, jacketed steam sterilizer can be used for this purpose by loading the chamber, closing the door, and turning steam into the jacket *only*. Overnight operation of the sterilizer for this purpose will cause minimal interference with busy daytime sterilizing routines.

Q. How many basins should be the maximum in a basin set?

A. You can put as many basins as you like in a set. Be sure they are nested loosely enough to allow steam to reach all surfaces and be sure they are *all* positioned in the sterilizer so that no air is trapped.

Q. How long are cellophane-packaged instruments considered sterile?

A. Properly packaged and sterilized at 250°F. for 30 minutes, these instruments are sterile until the package is opened. Care must be taken to protect these packages from shelf wear and extra handling. Grouping of instruments in transparent plastic boxes helps to minimize handling and sorting.

Q. Are there any variations in steam pressure to be considered when a hospital is located at an altitude of 6,000 feet?

A. The boiling point of water varies with altitude. At sea level, water boils at 212° F.; at 6,000 feet above sea level, water boils at 200° F. This same reduction in temperature occurs in the steam sterilizer. Therefore, to achieve the bacterial temperature of 250° F., the pressure under which steam is admitted to the chamber must be raised.

For every 1,000-foot rise above sea level, gauge pressure is increased 0.5 pound. At 6,000 feet, then, there should be a steam gauge pressure in the sterilizer of about 18 to 20 pounds. If your sterilizer is built to operate at a maximum of 20 pounds gauge pressure, your engineer will have to reset the safety valve if higher temperatures are desired.

The absolute pressure of steam at 250° F. (atmospheric pressure plus gauge pressure) is the same at all altitudes – namely, 29.6 p.s.i.

Q. If you find water inside a sterile Asepto bulb, can it be considered safe for use?

A. The water is sterile and hence not dangerous. But if the Asepto has been sterilized in a wrapper, the bulb should be discarded. Retrograde contamination from whatever unsterile surface the package may have contacted is inevitable because of the capillarity of the textile fibers.

Q. I would like your opinion as to the sterilization of wire on wooden coils. It seems to me that dry-heat sterilization is necessary for penetration of the inner layers of wire.

A. Dry-heat sterilization is a surface phenomenon and is accomplished by conduction. There is no problem of penetration. Wire sutures in dry heat conduct heat from one layer to the next. Similarly, an instrument in dry heat is heated on the surface and conducts heat to other instruments. If one attempts to sterilize wrapped articles in dry heat, the problem of penetration arises because the fabric conducts heat poorly and penetration is slow.

Wire sutures can be sterilized in dry heat (320°

F. for one hour; 250° F. for four hours) or steam (250° F. for 30 minutes—13 minutes if unwrapped). But in either case they should not be sterilized on wooden spools, because the heat drives lignum out of the wood and the minute deposits on the sutures, not seen with the naked eye, act as foreign bodies in the tissues.

Q. Are staples acceptable for closing cellophane packages, or is there some danger from the holes?
A. Stapling is an inferior method for closing packages. The holes encourage tearing and allow entry of bacteria. A better technic is one in which the end of the tubing, through which the sterile article will subsequently be removed, is closed with a paper clip before sterilization. The other end is closed after sterilization and sealed with tape.

Q. How long should Tygon tubing be allowed to rest after sterilization in ethylene oxide?

A. Tygon tubing can be used once it is clear. This usually means about two days after exposure to ethylene oxide.

Q. If rubber bands are contraindicated on glass ampoules being steam-sterilized, why do so many people use them to hold sponges together during sterilization?
A. A rubber band around a glass ampoule fits snugly — so snugly that steam is unable to sneak under the band, and, of course, it cannot penetrate the band. Steam sterilization depends on steam having easy access to all surfaces to wet, heat and sterilize.

Eventually, the glass does conduct heat to the surface protected by the rubber band, but it is dry heat; there is no moisture present. The thermal death time for destruction of pathogenic organisms in dry heat is much longer than the usual 30-minute cycle of a steam sterilizer. Hence, the surface beneath the rubber band is not sterilized by moist heat because the steam can neither penetrate the band nor seep in around it; neither is it sterilized by the dry heat conducted by the glass surface, because the exposure is too short.

Gauze sponges, on the other hand, are adsorptive and absorptive. They will take in steam throughout their fibers and become saturated, and moist heat will pass through to contiguous surfaces. Hence, the area protected by the rubber band is attacked from below, so to speak, by steam which fills the sponge's meshes. Thus, both the under side and upper surface of the rubber band are contacted by moist heat and sterilized, and the area under the band is in contact with a wet, heated sponge.

But there is an important reason for avoiding the use of rubber bands on sponges. The bands

are often old, weak, and ruined by heating. They decompose, and tiny fragments adhere to the sponge. These bits are not immediately visible. If implanted in the wound, they constitute a potential foreign-body reaction—a needless insult for the surgical patient who may already be overwhelmed with debility, disease or infection.

Q. We are now resterilizing all goods every 30 days. Do you recommend dating bundles prior to sterilization or after sterilization?

A. To minimize destruction from superheating, all sterile packs must be disassembled and textile and rubber components hydrated with distilled water (or by laundering) before resterilization. The double-thickness muslin wrapper, used so that four thicknesses cover a package's contents, is a good bacterial barrier, and if supplies are stored in clean, dry, vermin-free places, there is little justification in perpetuating the expense and destruction inherent in resterilization.

Inventories of sterile equipment can be maintained so that shelf stock is always that most recently sterilized. In instances when equipment may not be used for many weeks or months, the sterile package is wrapped in a plastic or paper wrapper to protect the sterilizing wrapper from dust.

Dating was originally a technic for recognizing supplies which had been sterilized. Recently, a pressure-sensitive sealing tape has outmoded this technic. Markings in the tape become apparent only after exposure to steam at 250° F. for a minimum of 15 minutes. While not intended in any sense as a sterility indicator, the tape does signify that the package and its contents have been exposed to steam within the bactericidal temperature range for the minimal time allowed for destruction of bacteria.

Personnel are conditioned to look for this change in the tape as they were once conditioned to look for a date before accepting a package as sterile.

Central supply rooms are too often undisciplined jungles of equipment and people. If packages are dated or marked in any manner, it should be done as supplies are removed from the autoclave, to avoid the inevitable mixing of sterile with unsterile supplies.

Q. We wrap our linen, syringes and instruments in a special brown paper and reautoclave all sterile supplies every 14 days. In a recent column you stated that supplies wrapped in muslin do not need reautoclaving. Does this principle apply to paper wrappers too?

A. If by "special brown paper" you mean the creped paper sterilizing wrapper, you are using a wrapper with qualities comparable to muslin. Supplies properly wrapped in this paper and stored

after sterilization in a clean dry place need not be reautoclaved.

If, on the other hand, you are using ordinary heavy brown wrapping paper, supplies are probably escaping sterilization initially, and no amount of resterilization will compensate for the inadequacy of this material as a sterilizing wrapper. These heavy papers make clumsy, bulky closures that seldom provide convenience in use or safety in storage. It is unlikely that any are penetrated by steam in the usual 30-minute sterilizing cycle.

Before accepting any paper for use as a sterilizing wrapper, obtain a reputable manufacturer's assurance and bacteriological proof that the paper is permeable to steam.

Q. When we used B. subtilis *test organisms from our own hospital laboratory, we never had any trouble with results, but now that we are using the bacteriological ampoules, we always get "unsterile" reports. We have an automatic sterilizer which has been checked by the company representative. We get reports of "unsterile" whether we put the ampoules inside or outside a pack.*

A. The organisms obtained from your pathologist may not have been sufficiently heat-resistant for testing purposes. If you are sure the air and condensate line on the sterilizer is clear and the serviceman can assure you that the thermostat is set correctly, the next move is to write to the ampoule manufacturer. Be sure to include the lot number of the ampoules you are using.

Q. Do you think it is a good idea to have a different linen pack for each service?

A. What you do about linen packs depends on your own experience and what is efficient for your organization. Standardization wherever possible makes for economy in purchasing and handling; and safety where a large number of ever-changing personnel are concerned.

Sterilization of Instruments and Materials with Beta-Propiolactone*

By Henry F. Allen, M.D., and John T. Murphy, Pharm. D.**

Modern medical and surgical practice uses many devices and materials which would be impaired by exposure to saturated steam or to hot air at sterilizing temperatures. Optical, electronic, and mechanical devices such as cystoscopes, radiation counters, and oscillating saws fall into this category. Many plastics and certain forms of rubber present similar problems. Because these devices and materials may come in contact with open wounds, disinfection or sanitization cannot be substituted for a true sterilizing process.

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**From the bacteriology laboratory, Massachusetts Eye and Ear Infirmary, the department of opthalmology, Harvard Medical School, and the department of pharmaceutical research and development, Massachusetts General Hospital, Boston.

Most substances used for "cold sterilization" are not sporicidal and are therefore not true sterilizers. As Spaulding[1] has pointed out, there is a significant difference between the resistance of certain spores and that of the vegetative bacteria which produce these spores. Selection of resistant spores for sterility testing should be limited to suspensions containing spores which survive exposure to constant-boiling hydrochloric acid for 30 minutes or more. Spore counts should be made only after pasteurization of the suspension to kill all vegetative forms. Spore suspensions should be allowed to dry on carriers.

Not only a susceptible test organism but also an inadequate sterility test medium can lead to a false

conclusion that a sterilizing process has been effective. By adding horse serum to the sterility test medium Klarmann[2] has shown that an apparent sporicidal effect after eight hours' exposure to a formaldehyde germicide was merely sporistatic. We have evidence[3] that fluid thioglycollate medium may fail to demonstrate germination of chemically insulted but still viable spores.

Most germicides have merely a disinfectant or antiseptic effect. No germicide having a rapidly lethal effect on resistant spores has found wide use up to the present time. More serious than mere lack of sporicidal effect have been instances of Pseudomonas contamination of quaternary ammonium compounds used as cationic germicides.[4] In ophthalmic surgery, such instances have had disastrous consequences. In all branches of surgery, the possibility of transmitting infection by means intended to prevent it must be excluded.

The ideal gaseous sterilizer, according to Lloyd and Thompson,[5] would be as follows: (1) noncorrosive; (2) harmless to materials; (3) penetrative; (4) easily removed by aeration; (5) rapid in action; (6) low in toxicity to human beings and animals; (7) nonflammable and nonexplosive; (8) convenient to store; (9) readily available commercially; (10) inexpensive; and (11) bactericidal, sporicidal, virucidal, and fungicidal at ordinary atmospheric conditions. We shall examine the extent to which some of these properties are held by the common gaseous sterilizers.

Formaldehyde and, more recently, ethylene oxide have been used as gaseous disinfectants or sterilizers at atmospheric temperatures. Still more recently, beta-propiolactone (BPL) has been shown to have marked sporicidal, virucidal, and fungicidal activity when it is used in aqueous solution for sterilization of tissues[6] and in the vapor-phase for sterilization of enclosed spaces.[7]

In spite of its marked activity against all types of micro-organisms, beta-propiolactone has attracted little attention among surgeons and even among those concerned with sterilizing processes in general. The omission of any reference to it in recent textbooks of sterilization[8] proves this point.

The properties of formaldehyde and ethylene oxide are described in these texts. Formaldehyde acts slowly, has an unpleasant odor, and tends to polymerize on surfaces, from which it is difficult to remove by airing. Ethylene oxide is flammable and explosive in air but is harmless to materials and has high penetrating power. Mixed with a suitable inert gas it can be dispensed from an aerosol bomb without danger of explosion. Its adaptation to ophthalmic sterilization has been described by Skeehan and co-workers.[9]

To obtain consistent sterilization with ethylene oxide in the hands of ordinary hospital personnel,

automatic control of humidity, temperature, gas concentration, and time is required. This entails the purchase of equipment costing about $5,000. Sterilization with ethylene oxide requires several hours under any circumstances.

Although beta-propiolactone is toxic to tissues and penetrates poorly, it is about 25 times more active as a vapor-phase disinfectant than formaldehyde and about 4,000 times more active than ethylene oxide when each substance is used under conditions of maximum effectiveness.[7] Its greater activity permits the use of small quantities of beta-propiolactone for rapid vapor-phase sterilization. Like ethylene oxide, it is easily removed by airing. Unlike ethylene oxide, it is nonflammable in the vapor state and nonexplosive.

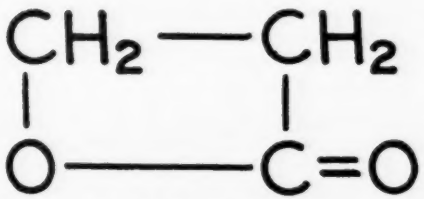
Beta-propiolactone requires a relative humidity of 75% or higher for rapid kill and is relatively ineffective at lower humidities. The properties led us to explore means of adapting this compound to surgical use for rapid sterilization of delicate instruments and materials in situations in which a surface effect, rather than deep penetration, would suffice.

Beta-propiolactone is a colorless liquid with the formula shown at right. The physical properties of beta-propiolactone are as follows[10]: boiling point (760 mm. Hg) 163°C.; melting point −33.4°C.; density 20/4 C. 1.149; vapor pressure (25°C.) 3.4 mm. Hg; water solubility 37% (by volume).

In aqueous solution, it hydrolyzes to form beta-hydroxypropionic acid. The products of its hydrolysis, which proceed to completion in minutes at an alkaline reaction, are relatively nontoxic and have no microbicidal activity.

The shelf life of purified (99%) or commercial grade (96%) beta-propiolactone is over three years at 4°C.[7] At higher temperatures polymerization proceeds at a rate proportional to the temperature.

Like other potent alkylating agents, beta-propiolactone is toxic to the skin, eyes, and mucous membranes of most species. A single drop of the pure liquid produces irreversible damage to the eye of the rabbit.[11] A 1% solution of beta-propiolactone was deleterious to corneal grafts.[12] Beta-propiolactone produces no immediate or delayed effect on the skin, provided it is washed off without delay.



Formula of beta-propiolactone.

To the time of writing we have not encountered any case of sensitization. We can report from personal experience that inhalation of the vapor produces headache, sweating, tachycardia, "bounding" pulse, epigastric distress, and malaise. However, in view of the minute quantities required for sterilization, beta-propiolactone should present no hazard when carefully handled. If it is accidentally spilled on a surface, flooding this with water or saline solution will initiate hydrolysis and retard vaporization. The acceptance of arterial and bone grafts[6] which have been sterilized with aqueous beta-propiolactone is evidence that no residual toxic effect persists after hydrolysis has taken place.

With these properties in mind we undertook to develop simple sterilizing procedures which would use existing equipment and would not involve the purchase of elaborate and costly devices. As a result of our experience with beta-propiolactone we believe that it can be safely used for sterilization either in the operating room or in the office by any physician or nurse having the incentive to become familiar with the technic and the simple precautions involved in its use.

MATERIALS AND METHODS

Test Organisms. Strains used in prior studies of gaseous sterilization were selected to represent the most resistant species likely to be encountered on surgical instruments. These strains were grown in cooked meat medium (ground beef-heart infusion) freshly prepared according to the method of Holman[13] and containing manganous sulfate, 5×10^{-5} M. After three days' incubation of cultures at 37°C., smears were stained with malachite green (5% aqueous solution) and examined for spore formation. Vegetative forms were killed by pasteurization at 75°C. for 60 minutes in a constant temperature water bath.

After homogenization in a sterile Waring blendor, serial tenfold dilutions of the uncentrifuged cultures of organisms yielded the following counts: *Bacillus subtilis (globigii)* strain 9372 (American type culture collection), 1.1×10^7 viable units per milliter; *Bacillus subtilis (niger)* strain 593 (Fort Detrick, Md.), 2.8×10^8 viable units per milliliter; and *Clostridium sporogenes* (obtained from the Wilmot Castle Co.), 2×10^7 viable units per milliliter.

Dried spores from these suspensions resisted constant-boiling hydrochloric acid for 30 minutes but not for 60 minutes. Vegetative bacteria were represented by *Staphylococcus aureus* ATCC 6538 and by a stock strain of pseudomonas.

Carriers. In most experiments standard suture loops, or paper strips, carrying about 5×10^5 dried spores per carrier, were used as test objects. In other tests, plastic or metal carriers or instruments

were immersed in or swabbed at selected spots with the stock suspension and allowed to dry. Viable vegetative organisms were streaked on blood agar in Petri dishes to be exposed to beta-propiolactone vapor.

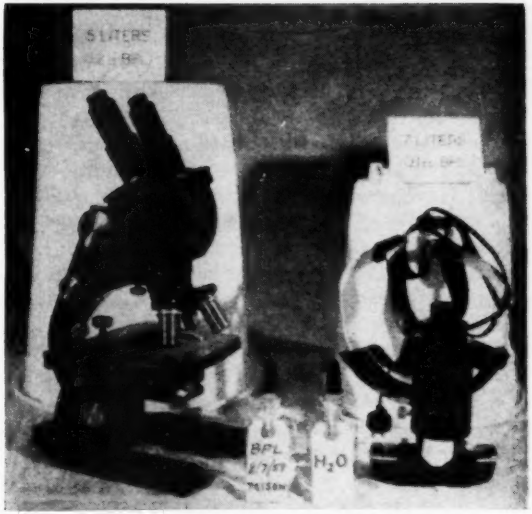
Sterility Test Mediums. For demonstration of viability after exposure to beta-propiolactone, reconstituted fluid thioglycollate medium and freshly prepared cooked meat medium were used. In a sufficient number of experiments, carriers showing no growth were subcultured to cooked meat medium containing 5% horse serum.

All cultures were incubated at 37°C., and those showing no growth were kept for 10 days at this temperature. The usual viability controls were included with each experiment and never failed to show growth. Test objects were handled aseptically with flamed hooks or forceps.

Assays were made of liquid beta-propiolactone, but no assays of vapor concentrations were done, other than determination of weight lost from liquid aliquots by vaporization.

PROCEDURE

Objects were exposed to beta-propiolactone either by immersion in an aqueous solution or by exposure to the gaseous phase of the compound. In the former case, sterilization occurs within a few minutes and instruments are ready for use after rinsing. In the latter case, sterilization can begin only after vaporization of sufficient concentration of beta-propiolactone and of water.



Microscope and opthalmoscope which have been sterilized with beta-propiolactone under inverted plastic wastebaskets.

Application of the gas laws reveals that the equilibrium concentration of beta-propiolactone in

the vapor phase at 25°C. and 760 mm. Hg is 13.2 mg. per liter, a concentration about eight times that found sufficient by Hoffman and Warshowsky[7] to kill 90 percent of spores in two minutes at RH 75-85% and 25-29°C. In order to provide a margin of safety and to speed sterilization, enough liquid beta-propiolactone was used to produce a saturated vapor in the sterilizing chamber.

The following three methods of promoting vaporization of beta-propiolactone were used in these experiments: (a) heating the liquid in an air stream; (b) atomization; and (c) reducing atmospheric pressure by drawing a vacuum. Of these three methods, the first and second can be used in a closed container which need not be hermetically sealed. The third requires an air-tight container.

A sturdy metal box, capacity 12 liters, was used for the experiments in which the liquid was heated in a stainless steel dish over a small resistance coil (50-watt). The coil was connected in a series with a small motor-driven fan and the surface of the dish was in the air stream from the fan. Only 0.16 cc. of beta-propiolactone was needed to produce an equilibrium concentration in this container. The temperature in the box reached 27°C.

The second method used to promote vaporization of beta-propiolactone was atomization. Any jet atomizer that produces a sufficiently fine spray would be suitable for this purpose. We found the DeVilbiss 33 pocket atomizer equipped with a DeVilbiss 40 bulb well suited to the small quantities involved. It must be used in the upright position and must therefore be inserted into a hole in the bottom of the chamber. This and similar atomizers can be used to spray beta-propiolactone and water into polyethylene envelopes and stiff containers closed with polyethylene film. Hermetic sealing is not required; however, there should be no circulation of air into the chamber nor appreciable diffusion of beta-propiolactone vapor to the outside during the sterilizing period.

For the third method of promoting vaporization of liquid beta-propiolactone, we used an ordinary vacuum desiccator, capacity 6.4 liters. This was fitted with a rubber stopper and connected with vacuum tubing to a water aspirator or a small vacuum pump. The time required to draw 29 inches of vacuum was less than five minutes. The amount of liquid beta-propiolactone passing into the vapor phase under these conditions was measured by weighing before and at the end of 30 minutes and was found to be 15 mg. per liter; that is, of the same order as the theoretical concentration.

Several successful experiments were conducted in inverted containers of 1 to 15 liters capacity in which liquid beta-propiolactone was simply dropped on a pledget of absorbent cotton or a paper towel. A few drops of water were dropped on another

Illustrating manner of handling beta-propiolactone container by tag attached to bottle neck.

part of the paper towel to provide the humidity necessary for the sterilizing action of beta-propiolactone vapor. Because the latter is heavier than air, it should be allowed to diffuse downward around the object to be sterilized.

RESULTS

With volumes of beta-propiolactone and water in excess of those required to produce equilibrium concentrations of vapor in the containers used, test objects and instruments up to the size of ophthalmic biomicroscope, all heavily contaminated with resistant dry spores or vegetative bacteria, were sterilized at 25 ± 2°C. within one hour by each of the four methods described above. More than 20 separate experiments were performed, each involving a number of test objects or instruments. The times required to kill different species are shown in the table below.

Sterilization Times at 25 ± 2°C. in Equilibrium Concentrations of BPL and Water Vapor

Organism	Form	Minutes
Bacillus subtilis (var. *niger*)	Dry spores	60
B. subtilis (*globigii*)	Dry spores	30
Clostridium sporogenes	Dry spores	60
Staphylococcus aureus	Vegetative	10
Pseudomonas aeruginosa	Vegetative	5

As is often the case in gaseous sterilization, occasional failures or "skips" occurred in the midst of a series of successful tests. These failures composed less than two percent of all tests, and no satisfactory explanation for them is offered.

During the past 14 months, beta-propiolactone vapor has been used by staff nurses for sterilization of ophthalmoscopes, electric cords, and lenses used in ophthalmic surgery at the Massachusetts Eye and Ear Infirmary. No complications have arisen from its use, and no instance of postoperative infection has occurred after an operation in which beta-propiolactone was used.

PRACTICAL CONSIDERATIONS

The resistant nature and large numbers of bacterial spores destroyed in these tests guarantee the margin of safety necessary for a sterilizing process to be used clinically. The essential reagents in the process are the vapors of water and beta-propiolactone. The effectiveness of the process is predicated on the diffusion or circulation of these vapors throughout the sterilizing chamber in equilibrium concentrations for one hour. Since only surfaces exposed to these vapors will be sterilized, contact between adjacent surfaces in the chamber should be avoided, and objects or materials must be unwrapped.

Beta-propiolactone must be stored and handled with due consideration for its toxic properties. For prolonged storage of stock quantities, polyethylene containers kept at 4°C. are recommended. For daily use, we have found a 30-cc. bottle with a ground-glass fitted dropper-stopper suitable for dispensing into an atomizer or on a disk of filter paper (Whatman no. 1) the few drops needed for a single sterilization.

This bottle should be clearly tagged, labeled, dated, enclosed in another glass container, and stored apart from all medicaments for external or internal use. Beta-propiolactone may be kept at 20 to 25°C. for one month but should be replaced from the refrigerated stock bottle at least once a month.

Incorporation of beta-propiolactone into an aerosol bomb, if this could be done without degradation of the active ingredient, might be dangerous if the spray were accidentally released in the direction of some person. We believe that hand-operated devices provide better control for dispersing the small quantities needed.

Removal of beta-propiolactone at the end of the sterilizing cycle presents no problem when small chambers are used. Much of the beta-propiolactone is hydrolyzed in the presence of water vapor, and the rest is dissipated almost instantly.

There is practically no limit to the size of objects or spaces which can be sterilized with beta-

propiolactone. Anything which can be enclosed in polyethylene film can be sterilized. Metal or plastic wastebaskets can be used as containers for microscopes and closed with polyethylene film. The interior and contents of any room, chamber, or building which can be made reasonably airtight can be sterilized with beta-propiolactone.[7]

The advantages of the use of beta-propiolactone for emergency sterilization in the absence of heat and power are obvious. Hospitals should have at least one person who is familiar with the simple technics described.

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Schley, Donald G., Hoffman, Robert K., and Phillips, Charles R.: "Simple Improvised Chambers for Gas Sterilization with Ethylene Oxide." *Appl. Microb.* 8:15, January, 1960.

Versatility in adapting available equipment for use with ethylene oxide is apparent in this description. An ordinary hospital autoclave, a common steel drum, and a polyethylene bag are successfully converted to gas sterilizers. All three modifications depend on a low-pressure aerosol can of ethylene-oxide mixture fitted with a flat cap which receives a needle valve, a can holder, and a hollow needle when the gas is to be released.

Exhaust and drain lines on an ordinary hospital autoclave were equipped with valves to convert the chamber to a sealed chamber. Gas was allowed to enter the sterilizer through a tap in the exhaust line. No vacuum was drawn because the authors found the gas mixture volatile enough to diffuse rapidly and penetrate porous material.

Two steel drums with locking lids were adapted for use as gas sterilizers by drilling holes in the lids to accommodate a pressure gauge, the needle valve and can holder. Material to be sterilized is placed in the drum; the lid is fixed in place; the gas is admitted, and the drum is rolled on its side a few times to distribute the gas evenly. Thereafter, the drum remains upright.

The third "sterilizer" is a polyethylene bag, 6 feet long and 2½ feet wide, made of 4 to 6-mil tubular film with a single bottom seam. The bag can be reused and withstands storage for prolonged periods without losing flexibility or gas-holding properties. The contaminated material is placed in the bag; the ethylene-oxide container and its cap, punctured by the needle valve, are placed at one side of the bag towards the center. The bag is closed snugly.

The can is grasped through the bag; the valve is opened, and the can is inverted. It is stressed that the can must be inverted to insure rapid release of the mixture when the can is opened. Otherwise, it will take 24 hours for it to empty if the entire contents of the can are to be dispensed. [*The entire contents are need-*

ed for kill in four to six hours. Ed.]

If the contents of the bag are not fragile, the bag is rolled through a full circle to insure spread of the gas. The gas mixture is a solvent for certain plastics; hence, caution must be used to keep the liquid disinfectant mixture away from sensitive materials until it has volatilized. In the bag sterilizer, the gas is led through a towel or other suitable material.

Ethylene oxide penetrates paper wrappers so that articles can be sterilized wrapped to prevent recontamination.

All tests were run at room temperature. Heavily contaminated material required exposure to 300 to 500 mg. of ethylene oxide per liter of air for six hours at room temperature (25°C.) to achieve sterility. Four hours exposure at this concentration was adequate to destroy spores of *B. subtilis* on laboratory instruments sterilized in the autoclave or bag.

The authors do not suggest that these modifications be used in place of permanent installations for ethylene-oxide sterilization, and they stress that there is no substitute for heat sterilization. But, in their hands, these vehicles are possible means for sterilizing non-heat-stable equipment in the laboratory or any type of material out in the field with no other facilities available.

principles and technics

INSTITUTIONAL SANITATION

By Howard Gadberry*

Because of the increase of hospital infections in the last few years, there is a need for an increased understanding of the basic principles of effective sanitation. If the spread of resistant infection cannot be checked, the physicians are going to have to relearn a lost art — how to fight infections without modern drugs.

The objective of sanitation is easily stated, but difficult to attain. The goal is to provide a psychologically attractive, physically clean and bacteriologically safe environment for people. Note that there is no mention of cost — there's the rub! Dirt and filth are frightfully expensive. In a well-run factory, it costs about $65 per pound to mop up dirt off the floors. A pound of dirt on an airplane costs $50 to remove and at least $100 a year to haul around.

In hospitals, surface soil probably costs over $100 a pound to remove. A large, well-run ward should not yield over one ounce of dust or soil, but this ounce can contain over ¼ million organisms.

At least 90-95 percent of the cost of cleaning and disinfecting represents labor cost. So the dubious economy of using cut-rate materials and equipment should be obvious. If costs have to be pared, one should look first at ways of increasing efficiency as measured by the area a workman can effectively cover in a given time. There is much need for new equipment to speed up and simplify the job of institutional sanitation. Further, like safety, sanitation is everyone's business, but someone must

*Head, Industrial Chemistry Section, Midwest Research Institute, Kansas City, Mo.

exercise centralized authority. If top management does not back the housekeeping and sanitation program, it can never be made successful from the worker up.

An operation that may represent upwards of five percent of total operating cost should have a responsible director with authority to carry out an efficient program. "The management of a cleaning program involves direct supervision of cleaning activities, worker training, purchasing of supplies and equipment, accounting and inventory control, planning and schedule of cleaning, and evaluation of cleaning needs and performance. These duties require more than a head janitor! An administrator of considerable ability should be provided with broad authority to keep the plant as clean and sanitary as possible at the lowest reasonable cost."[1]

The targets of institutional sanitation are generally two in number: the *air* and the *surface of objects*. Food, water, and drug sanitation are outside the scope of our present consideration. Around this surface versus air concept has clung a considerable controversy as to which was the more important. The goal is to minimize the chance of cross-infection. But, while enteric infections are largely transmitted by direct or indirect contact, respiratory diseases can be contracted from direct infection or by the aerial route in one or more of the following ways:[2]

1. *Droplet infection,* implying direct impingement of the ejected infective matter upon the mouth, open wound, etc.

2. *Infection by droplet nuclei,* implying inhalation of the minute residues of evaporation from droplets, which because of their size and lightness, remain suspended in the air for some time.

3. *Infection by contaminated dust,* representing the "secondary reservoir" of infective particles which accumulate on the floors, blankets, etc., and may become resuspended in air, especially after some mechanical activity such as sweeping or walking.

There is constant interplay and interchange of infective matter between the *carrier,* the *air,* the *floor and bedclothes, objects in the room* and the *victim*. This is diagrammatically represented in figure 1.

For this reason, it is important to remove most infective particles from the air. Some years ago the major attack was on the air itself. Ultra-violet lamps, [3,4] glycol vaporizers, etc., [5,6,7] were in vogue. Then came the oil bath, oiled floors, [8,9] oiled blankets, and draperies. [10,11,12,13] Currently the emphasis is on surface disinfection. Sanitize the floor, the table and the objects in the room and trust that removal of "secondary reservoirs" will minimize air contamination. There is no reason why we should be slavishly addicted to any single

technic which happens to be the present fashion. The object is to get *results*, not necessarily to follow a prescribed routine.

Methods

The surgery, the nursery, and the patient rooms or wards deserve special treatment. The public areas in institutions sometimes are sparingly disinfected. The methods used are doubtless so familiar that detailed mention is unnecessary. Wet mopping, canister care, washroom procedure, waste handling, bedding changes, and the swabbing of furniture are all aimed at minimizing the spread of infective matter, and should be properly designed to protect the sanitation personnel. These procedures can be designated as *routine, terminal* or *isolation technics,* depending on the nature and severity of pathogenic contamination encountered. Most equipment and chemical suppliers are only too eager to furnish detailed regimes for the use of their products.

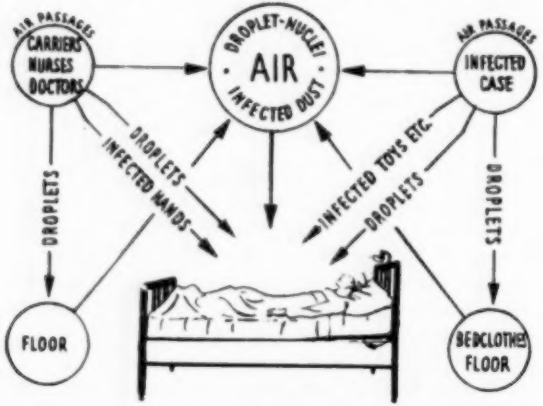

Fig. 1: Diagram of interchange of infective material in the hospital environment.

Measures

Assuming you have adopted a system for routine and special sanitation, how do you know if it is successful? The work on germ-free animal-colony raising at Notre Dame University has provided some of the best methods for measuring the degree of freedom from contamination. Most authorities are in favor of actual use checks. These can involve both surface "swab-rinse" [14, 15, 16] counts and air sampling for organism population.

A recoverable surface count of 100 viable organisms per 4-sq.-in. area with no more than one percent pathogens indicates that floors, utensils, and so forth, are well disinfected. Air counts are more variable, but comparative values will serve as a good check on both disinfection and dust-control measures.

If it is not possible to run routine checks on the efficacy of disinfection procedures, then the less

desirable method of comparative statistics must be used. Since the objective is to cut down cross-infection, one should look to the nursery as a sensitive indicator of the whole institutional sanitation level. The infants presumably come into the delivery room without benefit of external pathogens, and without acquired immunity. The infections infants pick up during their nursery stay rather accurately reflect the care taken in protecting the hospital environment. In fact, the very sensitivity of the nursery has led to the almost universal establishment of semi-isolation procedures.

However, spectacular results can be achieved in "rooming-in" hospitals *if* the disinfection procedures are most scrupulously observed. [17, 18, 19] Not a single case of infection was observed among 912 babies in the "rooming-in" division of Lebanon Hospital during the four and one-half years since the inception of rooming-in. [17]*

With this general look at the objectives, targets, methods and measures of sanitation, let us turn to the chemical materials employed.

Detergents

First, there are the detergents. Contrary to what you have heard, you *can* disinfect a dirty surface—but don't try it! For any reasonable sanitation technic, the chances of success are reduced 50-100 fold if the surface is dirty. Thus, effective detergents are the backbone of institutional sanitation.

The detergent materials employed include alkalies, surface active agents, and detergent auxiliaries such as water conditioners.

Most of the common detergents are mildly alkaline, about pH 10.5, and, on most surfaces, are satisfactory for cleansing away soil, grease, mucus, and other foreign materials.

Neutral detergents are generally preferred for delicate or sensitive surfaces but seldom are as effective as the alkaline compounds in cutting through heavy contamination. True, neutral detergents minimize the necessity for thorough rinsing, but rinsing is desirable if properly carried out. The three steps of *scrub, rinse* and *dry* are the best assurance of clean, streak-free surfaces.

A valuable technic called "alternate cleaning" can be adopted from the food industries. This procedure involves the use of alkaline detergents for surface cleaning on several days, followed by the use of a mildly acid detergent at selected intervals. This prevents the build-up of surface film or scum, which may eventually coat the surface if alkalies are used continually. In using this procedure, one should follow the manufacturer's in-

*The absence of crowding, with its accompanying hazard of cross-contamination, is also an important factor in the reduction of infection in such units.—*ED.*

structions both as to scheduling and concentrations used.

The synthetic surface active agents are well established as superior to soaps. It is claimed that nonionic detergents (of the high foaming type) are effective cleaners on more surfaces, and for more soil types, than are the older, anionic agents.[20, 21] Certainly a properly formulated, built nonionic is an effective cleaner that lends itself to versatile use, and does not destroy the effectiveness of germicidal agents.

Do not be misled about synthetic detergents. The fact that they do not cloud or scum in hard water does not mean that they are unaffected by water hardness. Tests show that even Kansas City tap water at 90 ppm hardness considerably reduces the cleaning effectiveness of detergents compared to fully softened water.[22] In hard water areas one should use either a detergent specifically designed for hard water effectiveness or a separate softening treatment for scrub water. Resin type, ion-exchange softener systems are most preferable, but detergent auxiliaries such as the EDTA softening tablets are a satisfactory compromise.

Disinfectants

It is in the field of disinfectants that the greatest controversy and misunderstanding occurs. The types of germicidal agents generally encountered can be classed as:

1. Pine oil disinfectants
2. Chlorine and hypochlorites
3. Phenolic compounds
4. Quaternary ammonium compounds
5. Mercurials, organic and inorganic
6. Oligodynamic metals
7. Iodine compounds and complexes
8. Miscellaneous agents.

The number of agents in each class and the confusing results reported make generalizations risky. So before discussing the merits of individual agents consider:

1. Label information
2. Disinfectant testing
3. Requirements for a hospital disinfectant.

Labeling

Germicidal agents sold interstate are required to be registered with the U.S.D.A. under the Federal Insecticide, Fungicide and Rodenticide Act. The following information is compulsory, and *must* appear on every label.

1. **Name and address of manufacturer**
2. **Name, brand or trademark under which sold**
3. **Net contents**
4. **Statement of ingredients**
5. **Appropriate warning or caution statements**
6. **Use directions.**

The last item, the proper use of directions, can

optionally be given in so-called "labeling" which can include pamphlets or booklets accompanying the package.

Thus, for the user the label should provide detailed and accurate information regarding the contents, the active ingredients, special precautions, chemical compatibilities, and most important, the proper dilution and procedures recommended for: (1) general disinfectant uses; (2) disinfection of surgical appliances and instruments; (3) special anti-fungal uses; and (4) antiseptic uses.

Note that the phenol coefficient is *not* required on the label. If it happens to be given, the best thing to do is to disregard it. Phenol coefficients on labels are more apt to mislead the user than to help him.

The thing that is wrong with most labels is that they are not carefully read and followed. The user should follow the use instructions provided by the manufacturer rather than caleulating his own.

Testing

The accurate testing of germicidal powder is almost impossible. The principal factors which confuse the testing include concentration, time, temperature, volume, the test organism used, the presence of protein, pH, surface tension, mechanical scrubbing, and ionic equilibrium. For many years the Rideal-Walker procedure was used to compare the potency of agents relative to phenol. The method is still used with certain modifications, but now it is recognized that the term "phenol coefficient" is more misleading than helpful.

It was originally intended that five percent carbolic acid be used as a standard of known efficacy for killing *S. typhosa,* and that the dilution necessary for a product to equal this standard could be obtained simply by multiplying the phenol coefficient by 20.

This only works, however, if the agent is chemically similar to phenol and acts to kill germs in the same way as phenol does. It is dangerously misleading to use this simple calculation of use dilution on chlorine, iodine, mercurials, pine oil, or other agents radically different from phenol.

It cannot be accepted, as has been commonly assumed, that germicides used at dilutions equivalent in efficiency against *S. typhosa* to five percent phenol at 20°C. in the phenol-coefficent method will possess reasonable margins of safety for the destruction of infective organisms. The cleaning processes used on floors, walls and equipment are often of a superficial nature and cannot be relied upon to reduce the amount of interfering organic matter sufficiently.

Therefore, many germicides do not kill infective organisms at 20 times their phenol-coefficient values. This variable behavior of commercial disin-

TABLE I

Results Obtained with Selected Commercial Germicides of Different Types in the Phenol Coefficient and Use-Dilution Confirmation Tests[16]

Germicides By Type	Phenol Coefficient (S. typhosa at 20°C)		Use-Dilution Confirmation Tests*	
	Claimed	*Found*	Max. Safe Use Dilution (*C. cholerasius*)	Max. Safe Use Dilution (*M. pyogenes var. aureus*)
Pine Oil				
1	5.0	5.0	1:100	Undiluted
2	3.0	3.0	1:60	1:5
3	5.0	5.1	1:100	Undiluted
4	5.0	4.7	1:100	1:5
5	4.0	4.2	1:80	Undiluted
Pine Odor				
1	5.0	5.0	1:5	1:5
2	3.0	3.0	1:60	None
3	5.0	5.0	1:100	1:5
4	5.0	5.0	1:100	None
5	5.0	5.0	1:20	1:100

Phenol Emulsifying				
Type				
1	5.0	5.2	1:40	1:20
2	5.0	5.0	1:100	1:20
3	5.0	4.7	1:80	1:20
4	5.0	5.2	1:60	1:5
5	5.0	5.0	1:40	1:80
6	32.0	36.0	1:640	1:640
Phenolic Soluble Type				
1	4.0	4.0	1:80	1:40
2	4.0	4.2	1:80	1:80
3	5.0	6.7	1:100	1:80
4	4.0	4.4	1:80	1:80
Quaternary Ammonium				
1	25.0	25.0	1:100	1:100
2	20.0	22.2	1:50	1:50
3	25.0	23.3	None	None
4	5.0	5.0	1:5	1:5
5	25.0	25.6	1:60	1:60

*The maximum dilutions tested were no greater than those indicated to be safe by conventional calculations using the phenol coefficient claimed.

fectants is shown in Table I.[16] It can be seen that some agents are safe at dilutions computed from phenol-coefficient values, but many are not safe.

Two of the major factors which confuse the measurement of germicidal activity are bacteriostasis and inactivation. Those agents which temporarily stop the growth of organisms give falsely high values. So do the compounds whose power is destroyed by proteins or other organic matter.

There are three principal ways of testing germicides more realistically. These are *test tube methods, animal tests,* and *use tests.* Practical conditions can be simulated in the test tube by drying the inoculum on the test surface and measuring the kill in the presence of serum, cystine, or thioglycolate. Another way is to treat the test organism with the germicide and then inject a small amount into a rat's tail. The useful dilution is the highest one that protects the animals. Finally, the product may be tested in use: for example, in sterilizing deliberately contaminated surgical scissors. For greatest security, a profile of germicidal activity in a whole series of test procedures is the most useful.

Because of the confusion resulting from the phenol-coefficient determination, the U.S.D.A. has adopted the "use-dilution confirmation test"[16] to calculate recommended use strengths. A product whose recommended use-dilutions fail this test may be considered misbranded.

From consideration of the conditions of use and the performance desired, sensible disinfectant specifications covering these products can be set up. Klarmann[22] and others have outlined useful specifications for purchasing institutional disinfectants. Such specifications can be based on a combination of tests, some made in the presence of 10 percent horse serum, and may include:

1. The AOAC phenol coefficient against *S. typhosa* and *Micrococcus pyrogenes* var. *aureus*
2. The AOAC use-dilution confirmation test with the same organisms.
3. The AOAC fungicidal test against *Tricophyton interdigitale*
4. The use-dilutions found to destroy *M. tuberculosis, E. coli, Pseudomonas,* hemolytic streptococcus, pneumonia, diptheria and dysentery organisms.

These tests, together with specifications covering solubility, pH, odor, stability, toxicity, irritation, and residual action, help to define the requirements for a modern disinfectant.

The importance of an agent which remains bactericidal on the surface to which it is applied should not be overlooked. Thus, a modern disinfectant can be described as having:[2]

"Demonstrable, true, nonspecific effectiveness against the most resistant of respiratory and enteric pathogens. Activity against fungus, virus and spores

is desirable. Other things being equal, an agent which offers a lasting antimicrobial blanket is deemed preferable to one having short-term effectiveness, no matter how pronounced."

Now let us examine the individual and class characteristics of various germicides.

Pine oil disinfectants are not capable of killing micrococcus. This, together with their odor and tendency to streak, make them more suitable for public washrooms than for critical uses in hospitals.

The hypochlorites and related products are low-cost, fast-acting, broad-spectrum agents for use in sanitizing already *cleaned* surfaces. The activity is largely lost in the presence of soil and organic matter. There is no residual action.

Mercurials, both inorganic and organic, are pronounced bacteriostats and can be partially inactivated in the presence of blood or organic matter. While they are frequently advocated for "cold sterilization" because of their sporicidal action, recent evidence has shown them to be generally ineffective under practical conditions.[23, 24]

The oligodynamic metals, such as silver and copper preparations, are slow in action, largely bacteriostatic, and tricky to use. But they are outstandingly mild and extremely persistent in their residual activity when absorbed on either hard surfaces or textiles. Silver sols are of some use in treating drinking glasses and carafes, as well as rendering dressings and linens residually germicidal.

Quaternary ammonium salts as a class vary considerably in their ability to deliver, at use-dilution, the potency promised by simple test-tube evaluation methods. The products are good deodorizers and are noncorrosive. Some skins are sensitized by repeated contact. The products are inactivated by soaps and by most hard waters. Used as a final rinse, many of these "quats" provide residual activity on textiles such as diapers.

Iodine preparations, especially the non-ionic iodophors, are especially noteworthy because of their nonselective, broad spectrum of activity. The products are fast-acting, noncorrosive, and nonirritating and are fairly good detergents. The residual activity is prolonged for several days, and the color of the solution provides an indication of the depletion of activity.

Because iodophors inactivate spores, viruses, protozoa, fungi and yeast spores, as well as resistant bacteria, they are partially useful for isolation and terminal disinfection.

Phenolics take us back to the time of Lister, but still are among the most satisfactory germicides. Modern phenolics based on substituted or chlorinated phenols are mild in odor, and nonirritating. They have prolonged residual activity. In actual

use they deliver the killing power indicated by laboratory tests. Phenolics kill fast, and are effective against most resistant organisms.

However, it must be emphasized that the materials used in sanitation can be no better than the care taken by the people who use them.

Only by a return to rigid sanitary procedures can our institutions prevent the spread of infection. Implementing the more drastic program of sanitation necessary for better infection control requires four steps on the part of an enlightened management:

1. Decide on realistic objectives to be accomplished.

2. Design a scheme of procedure that will insure adequate and frequent coverage of all target areas. Use the best equipment available.

3. Set up strict specifications for disinfectants and select materials on the basis of a wide profile of modern test methods to meet your actual requirements at reasonable cost.

4. Measure the degree of accomplishment of your objectives by on-the-spot tests of surface and air contamination.

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Precautions in Burn Ward Guard Against Infection Spread

By Lt. Col. Wilfred T. Tumbusch, MC*

Precautions and procedures used at Brooke Army Medical Center to prevent cross-contamination of patients are shown in the film, "Hospital Infection Control," made by the visual aid section of the Surgical Research Unit. HOSPITAL TOPICS *presents selected scenes from the film, with explanatory comments by Lt. Col. Tumbusch, chief of the unit's clinical division.*

*Chief, clinical division, U. S. Army Surgical Research Unit, Brooke Army Medical Center, Fort Sam Houston, Tex.

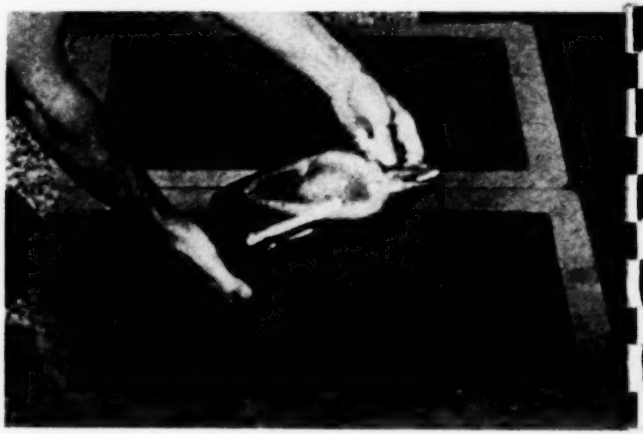
Since approximately 60 percent of the patients who die following thermal trauma die of invasive infection, it is most important that every effort be made to eliminate or reduce the number of bacteria on burn wound surfaces and in the environment in which these patients are treated. This could be best accomplished by practicing complete isolation of the patient from other patients; however, this is not possible in most hospital settings because of the increased work load inherent in these technics.

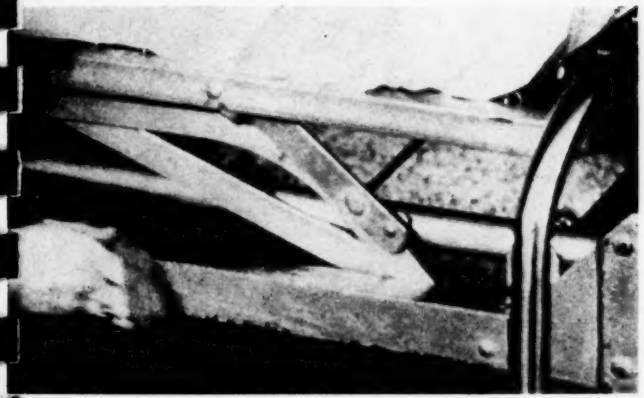
Above: Nurse walks across a germicide-saturated mat which has been placed between the patient area and the sterile supply room.

It is believed that the next most effective approach to the cross-contamination problem is to set up barriers which would impede organism transmission, minimize the number of bacteria, and initiate measures to obtain the earliest possible closure of the wounds by skin grafting.

The motion picture, "Hospital Infection Control," depicts our attempt to reduce the amount of bacteria allowed to enter the burn ward. At the entrance of each ward is placed a mat which is kept wet at all times by frequent applications of an iodine germicidal solution. All personnel who enter the ward wipe their feet upon entering. All vehicles (food carts, x-ray machines, litters, and other special equipment) necessarily are rolled over the saturated mat, and liberal contact with the germicidal solution is made on all floor-touching surfaces.

Mats placed at the entrances to the ward are frequently saturated with a germicidal solution, so that the undersurfaces of shoes and the wheels of vehicles are placed in contact with the germicidal agent.



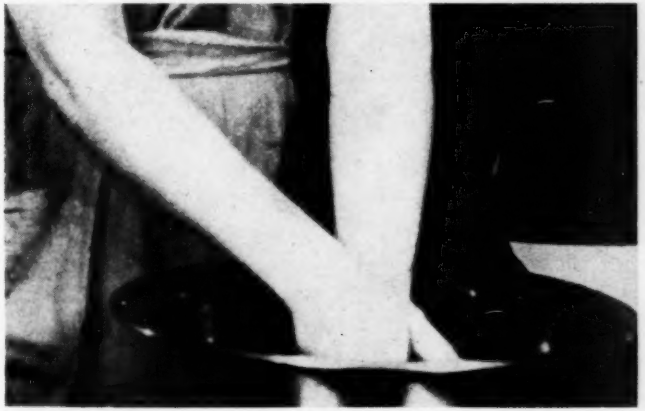


Frequent decontamination of the standard hospital bed is accomplished by liberally applying a germicidal solution.

This does not sterilize the undersurface of shoes, nor does it sterilize the wheels of the vehicles; however, considerable dirt and considerable numbers of bacteria are removed and actually destroyed during this exposure.

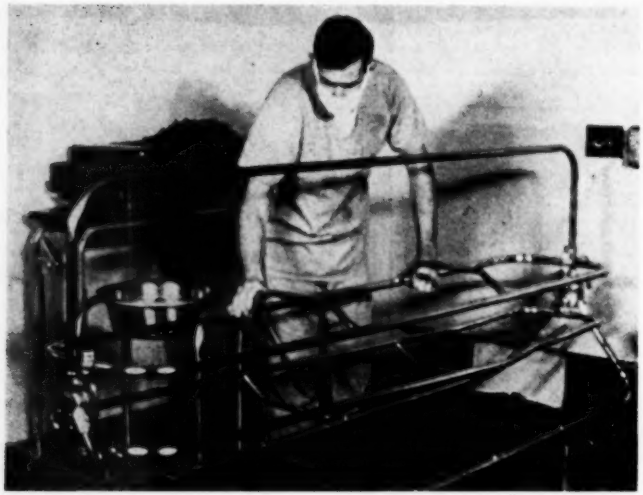
Since the bacterial count in the atmosphere on the burn ward is high, as demonstrated by high counts in air-sampling procedures, and these counts are higher during periods of activity of attending personnel, visitors, and others, all unnecessary activities by members of the staff are minimized. Also, because the bacterial counts are high in cultures taken from the walls, floors, and equipment used to care for the patients, these things are washed at frequent intervals with a germicidal solution. It is thought that this procedure is beneficial in reducing the total count of bacteria on the ward.

Below: All attending personnel wear clean surgical scrub suits while on duty, in lieu of street clothing or uniforms. Attendant rinses hands in basin of germicidal solution at patient's bedside.



There is one room set apart from the ward which is large enough to accommodate eight patients. A patient is treated in this room until his burn wound is reduced greatly in size or until we believe the patient is out of danger, whereupon he is transferred to the open ward.

Below: Equipment not in use is decontaminated by applying germicidal solution. It is covered with a clean sheet, and is again decontaminated before it is put into use.



Above: The undersurface of a Stryker frame is being decontaminated by application of a germicidal solution.

In this room, the strictest precautions against bacterial contamination are practiced. All personnel and visitors who enter this area must be gowned and masked, and must then wash their hands and rinse them in the germicidal solution.

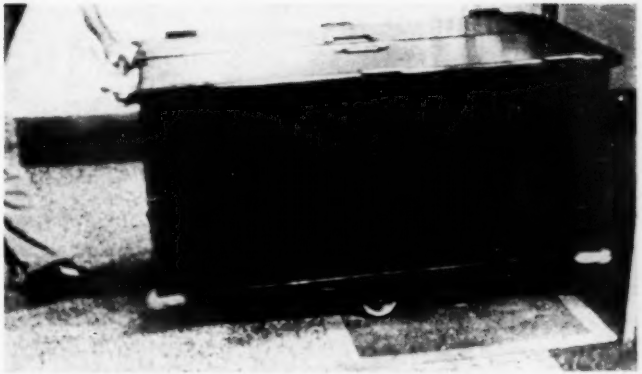
Personnel who take care of the patients in this cubicle are assigned for an eight-hour shift and leave the room only for urgent reasons. At each patient's bedside is a basin containing germicidal

solution which is used for rinsing of the hands before and after a treatment or procedure on the patient. The solution in these basins is changed every four hours.

Each patient has his own thermometer, stethoscope, and blood-pressure apparatus. Any other equipment that will be repeatedly used is kept at his bedside and is not used on another patient unless it has been decontaminated with the germicidal solution.

When dressings are changed, they are put into paper bags and removed immediately from the patient area. Surgical instruments used for minor procedures on the ward are immediately decontaminated by soaking in the germicidal solution and then thoroughly washed before they are returned to the central medical supply for resterilization.

On the open ward, precautions against cross-contamination are not nearly so rigid. Here the patients are undergoing the final stages of grafting and healing, and they pass into the convalescent phase.



All carts entering or leaving the ward roll over the saturated mats. Here a metal hamper containing contaminated linens is removed from the ward.

ACS Panel Discusses Methods of Infection Control

Control of infections in hospitals—a major concern of surgeons—was the subject featured at the opening session at the 45th annual clinical congress of the American College of Surgeons in Atlantic City.

Moderator of the panel discussion was **Carl W. Walter, M.D.,** associate clinical professor of surgery, Harvard Medical School, and surgeon, Peter Bent Brigham Hospital, Boston. The panelists were chosen, Dr. Walter pointed out, because each had data which answered various categories of questions received by mail since the request for questions was published in the *Bulletin of the American College of Surgeons* in the spring of 1959. Panelists were:

David V. Habif, M.D., associate professor of clinical surgery, Columbia University College of Physicians, New York City; **Ruth B. Kundsin, Sc.D.,** assistant in surgery, Peter Bent Brigham Hospital, Boston; **H. Rocke Robertson, M.D.,** professor of surgery and chairman of the department, McGill University Faculty of Medicine, and surgeon-in-chief, Montreal General Hospital, Montreal, Que., Canada; and **Robert I. Wise, M.D.,** Magee professor of medicine and head of the department, Jefferson Medical College, Philadelphia.

Other physicians who were asked to speak from the floor to present current developments of special interest to a number of hospitals were:

Robert E. De Sautels, M.D., urologist, Boston, Mass., and **Chester W. Howe, M.D.,** associate professor of surgery, Boston University School of Medicine, Boston.

The subject for discussion was introduced by showing the film, "Hospital Sepsis: A Communicable Disease."*

*This 30-minute film can be obtained on loan from the American College of Surgeons, the American Hospital Association, the American Medical Association, or Johnson & Johnson.

A preview of the film appeared in the September, 1959 issue of HOSPITAL TOPICS, p. 27-30.

Objective of the program, said Dr. Walter in his introductory remarks, was to provoke everyone attending it to action and to provide the information essential to his playing a leading role in ridding hospitals of the faulty practices which permit the accumulation of bacteria to such a degree that outbreaks of sepsis occur. The discussion follows.

Discussion

Q. Dr. Habif, what, in your opinion, is an acceptable wound-infection rate for clean surgery?

DR. HABIF: The over-all acceptable rate is no more than two percent for contaminated cases. The rate should be one percent or lower for clean surgery.

Q. Dr. Wise, what has been your experience in culturing wounds immediately prior to closure?

DR. WISE: Sterile solution was instilled in 54 wounds immediately prior to closing, aspirated and cultured. Of the 54, 59.3 percent were contaminated with staphylococci; nine of these were coagulase-positive but not typeable. These non-typeable strains found in the operating room could not be traced to any infections.

Q. Dr. Habif, what do you consider the most common factor in the development of wound infection?

DR. HABIF: I would say the single most important factor is some break in wound technic. Every gram-positive cocci wound infection was investigated in our surgery, and in every instance a break in technic could be documented. The most common causes appear to be hematoma and an excess of foreign body in the wound.

Q. Dr. Habif, what is your feeling about local antibiotics?

DR. HABIF: It is difficult to evaluate their worth, but my impression is that they do not significantly contribute to decreasing wound infections. If there is foreign body or hematoma present, local antibiotics act for a short time only. A wash with normal saline would probably be just as effective.

Bacitracin and neomycin used locally help to decrease local purulent discharge and odors. Instillation in a pleural cavity without drainage may also be of some benefit to the patient.

DR. ROBERTSON: I agree with Dr. Habif. It has been shown experimentally that massive doses of local antibiotics are necessary to prevent infections. General administration of prophylactic antibiotics is entirely unnecessary in clean surgery. When an obstructive lesion is the problem, the situation changes, and in this instance, prophylactic antibiotic therapy is indicated.

Q. Dr. Wise, what has your experience been in studying the antibiotic sensitivity in non-hospital strains of staphlococci?

DR. WISE: There is a very real relationship between an organism's sensitivity to antibiotics and its prevalence in a hospital. Doctors' offices throughout 49 states were circularized and each patient with an infection was asked three questions: "Have you been in a hospital in the last year?"; "Has any member of your family been in a hospital in the last year?"; "Do you have an infant in your household under the age of 2?"

Thirty-one percent of infections reported were of the 80/81 type. This percentage reveals an increase in prevalence of this strain among the general public.

If answers to all three questions indicated no relationship to a hospital, the strains were sensitive to all antibiotics in 66 percent of the cases. As the relationship to a hospital became more defined, antibiotic resistance went up.

Q. Dr. Habif, how important do you think phage typing is for the average hospital?

DR. HABIF: Phage typing will help a hospital understand its epidemiological problem but otherwise is of no practical value. People with money and adequate facilities can do phage typing but are still likely to find about 50 percent of cultures non-typeable.

DR. WISE: We have been able to type over 80 percent.

DR. WALTER: In Boston, 60 percent are non-typeable.

DR. ROBERTSON: In Vancouver, about 80 percent were typeable. About six types were common.

DR. WALTER: Phage typing is a good tool for the epidemiologist and ecologist but of very little importance in the care of the patient.

Q. Dr. Kundsin, how do you detect the carrier among hospital personnel?

DR. KUNDSIN: A simple culturing of the nasal fossa will give data instantly. However, environmental cultures are necessary to detect the carriers and consistent spreaders. We did air cultures in the operating room and then cultured the floors in the house officers' quarters to find out which young man was the disseminating carrier.

DR. WISE: It is most important to find the *disease-causing* staphylococci carriers. Even a coagulase-positive strain may be unimportant if it does not cause infection. We are concerned with four disease-causing strains and routinely culture our personnel to find carriers of these strains. Neomycin in the

noses of carriers will eliminate the organisms but only temporarily. They inevitably return after the treatment is stopped.

DR. WALTER: Many types of treatments for patients have come under careful scrutiny to determine their potential roles in infections. The indwelling catheter has long been considered a source of trouble. Dr. Robert DeSautels has recently completed a study of this problem.

DR. DE SAUTELS (*by invitation from the floor*): A gram-negative infection accompanying use of an indwelling catheter is almost inevitable. However, urinary-tract infections do not result from the use of the catheter itself but rather from careless daily care of the system. Good aseptic technic is necessary to avert these infections. One must use a sterile system and keep it as nearly sterile as possible.

The catheter in contact with the urethra offers a port of entry for bacteria along the potential space between the catheter and urethral wall. Bacteria are most commonly introduced by careless irrigation, by the connecting tubing's coming apart, or by a stopper's coming loose and allowing drainage tubing to trail on the floor. The bacteria migrate up the lumen of the tubing and catheter.

Irrigation equipment is cleaned daily with Zephiran at all connecting points. A wet Zephiran dressing is kept in place at the meatus. If there is any question of contamination of the system, it is replaced with a sterile unit.

Tests were done to determine the efficacy of catheters impregnated with an antibacterial agent vs. the use of good aseptic technic. In 45 instances in which the Zephiran meatus dressing was employed, there were 35 negative cultures and 10 positive. When an impregnated catheter was used in another group, there were 28 negative and 3 positive.

Q. How would you treat the patient appearing in your office with an infection?

DR. WISE: If that patient had no relationship to the health industry, I would give him penicillin.

Q. What is your program for treating the patient with recurrent furunculosis?

DR. WISE: Two years ago we started studying the hygiene of this group of patients and as a result have certain specific recommendations to make. The patient must be oriented to his illness. The factors of spread and reinfection must be discussed. The patient should understand that organisms will survive a month or longer and that if he can help prevent the formation of new abscesses, the old ones will be cured and he will be free of disease. The patient is instructed to cover his mattress and pillow with plastic covers. Every morning, his

sheets, pajamas, and pillow cases go directly into the laundry. The plastic covers are disinfected.

After the patient takes a soapy shower or bath, the infected area is cleaned for five minutes with 70 percent alcohol, and covered with neomycin ointment and a gauze dressing. Cellulose tape is used in lieu of adhesive tape to minimize trauma to the skin.

The patient is told that organisms will multiply in six hours and the shower or bath must be repeated. Underclothing is changed with each shower, if possible. Ideally, the routine should be carried out in the morning, at noon, around 5 or 6 p.m., and again at bedtime.

The program must continue for a minimum of one month after the infection has been stopped. No antibiotic is ordered unless the lesion is in a dangerous position.

Each member of the family is instructed to place neomycin ointment in his nose morning and evening.

Q. Dr. Wise, what has your experience been in culturing the skin of surgeons' hands?

DR. WISE: Of 481 glove cultures, 438 (90 percent) were contaminated with staphylococci (69 coagulase-positive): 32 were contaminated with a variety of organisms and yeast; 11 were sterile.

Q. What skin preparation was used prior to these tests?

DR. WISE: An 8-10 minute scrub with hexachlorophene liquid soap.

DR. KUNDSIN: We cultured 198 gloves after they were worn by hands prepared by scrubbing with a synthetic detergent containing hexachlorophene and a dipping in 1:750 aqueous quaternary after the scrub. There was no correlation between the number of organisms isolated and the time the gloves were worn. There were extremely high counts in persons with dermatitis. Twenty-six percent showed no organisms/ml. of glove juice; 38 percent showed only one organism/ml. of glove juice. Only four percent had significant numbers of organisms.

Q. Dr. Wise, what percentage of gloves used did you find punctured?

DR. WISE: About 10 percent.

DR. WALTER: In Boston, our figures run from 25 to 30 percent.

Q. If it is impractical to use a wet technic for floor care*, how good is plain mopping, using a new mop head every day?

*ED. NOTE: For a description of a "wet pick-up" technic used in floor care, see "Disinfection of the Floor to Prevent Cross-Infection" by Carl W. Walter, M.D., in the September, 1959 issue of HOSPITAL TOPICS, pp. 80-81.

DR. KUNDSIN: So many germicides are absorptive that there is always the possibility of all active ingredients being eluted by the textile mop. When the wet technic is used, however, the maximum concentration of germicide reaches the floor.

Between cases, one can certainly mop operating-room floors, using fresh detergent solution for each room; but the practice of letting mops stand overnight creates a hazard.

DR. WALTER: The big problem in many operating rooms is that dirt and detritus accumulate. The chief advantage of using a vacuum pick-up technic is that the floor is actually rid of this debris and blood and pus are removed completely and do not remain in amounts adequate to neutralize most germicides.

DR. ROBERTSON: I firmly believe that environmental bacteria are virulent, but it is difficult to prove. There is satisfactory experimental evidence that dried-out organisms will infect the laboratory animal, but evidence that this same mechanism will work in a human is difficult to accumulate, because human volunteers are not easy to find. I know of a pathologist who inoculated himself with dried-out media from an infected patient and did get a full-blown infection.

Q. Dr. Habif, what are your sentiments regarding ultraviolet radiation in the operating room?

DR. HABIF: In some previous work done with ultraviolet we could see no significant difference in cases done with or without ultraviolet radiation in the room. Recently we have started experimenting again to reassess its value.

We personally feel the single most important factor is a good air-conditioning system operating under positive pressure with 8-12 exchanges of air per hour (one full exchange every six minutes). There are rises in air-borne counts when there is heavy traffic in the operating room and when someone with an upper respiratory infection is present. We are currently working to determine whether ultraviolet light would be feasible and practical to augment the air-circulating system.

Q. Dr. Robertson, what policy do you suggest for handling personnel with skin infections?

DR. ROBERTSON: These persons should be kept away from any work associated with patient care and should be paid compensation for their period of unemployment. Their treatment at home should be as outlined by Dr. Wise.

Q. How should the acutely infected postoperative wound be handled?

DR. CHESTER W. HOWE (*by invitation from the floor*): Infected wounds are a hazard to patient and personnel alike. The products of necrosis

must be removed. This can be done with a debridement and excision of all dead tissues. A contaminated wound is thus converted to a clean wound.

Catheters may be left in place for injections of antibiotic solutions. Obliterating gauze rolls are used to close over open spaces. An occlusive dressing is applied and sealed in place.

In the treatment of 180 patients over a 10-year period, there has been 95 percent success. Failures occur in the obese patient, the severe diabetic, or patients with severe debilitating disease. One must always weigh the hazard of a second anesthesia against the hazard of the prevailing infection.

DR. WALTER: Dr. Robertson, how do you handle the surgeon or doctor who won't obey rules; who won't wear a mask properly; who insists on wearing his street clothing in the operating room; whose behavior is less than professionally ideal? How do you get this man to set a good example for the rest of the hospital?

DR. ROBERTSON: Education must come first. More can be accomplished with education than with persuasion. Show these men the hospital problem; try to enlist their aid. There are certain refractory individuals in every hospital. The older surgeon who insists on wearing his mask below his nose is but one example. It is difficult to change the habits of a lifetime in these people.

It is very important to be sure of your information. A long argument on an inconsequential point can lose you much ground in your campaign to bring the staff into line. Then, it must be recognized that certain things must be forced on the staff if they do not volunteer their cooperation.

(The following four abstracts are taken from papers presented at a program on infection control, during 1960 sectional meeting of the American College of Surgeons.)

Lists Oft-Mentioned Precautions Needed in Infection Control

Cross-infection is a complex problem. Perhaps few technics instituted as controls have any proven value, but many seem reasonable and have been shown to be practical. Though more work is needed to prove their value, collectively they provide a strong barrier against cross-infection.

Infected patients must be isolated. Personnel with infections must be encouraged to declare themselves. Compensation should be provided so that these people need not be punished economically for what is a true occupational hazard. The physician is in a difficult position. His only compensation may be in knowing he has done the right thing by staying away from practice while infected.

It may be difficult to prove that bedding is dirty – but who among us would want to be admitted to a bed with a mattress which recently cradled a patient with an infection? Pillows can be laundered; blankets can be treated with antiseptic rinses. Substituting cotton blankets for wool may be an answer to the problem of making the wool blanket safe.

Mattresses pose another difficult problem. Plastic cases are likely to be uncomfortable for the patient. Laundered and treated covers made of ticking may be effective barriers but are cumbersome and less than ideal.

Wet mopping and wet dusting will certainly help in dust control. In time multipurpose cleaning machines may be perfected for cleaning isolation units.

Baths and toilet seats are sources of contamination, and disinfection facilities must be provided. Handwashing facilities must be ubiquitous. It is difficult to eliminate bar soap from the hospital. Custom dictates its use. As often as we get rid of it, it reappears.

The dressing trolley is certainly contaminated before the day is over, although it may be hard to pinpoint the error leading to infection from dressing technics. The individual tray technic may be a nuisance, but it brings results, particularly if enforced by a dressing team or nurse who supplies close supervision.—*H. Rocke Robertson, M.D.*, professor and chairman, department of surgery, McGill University Faculty of Medicine, and surgeon-in-chief, Montreal (Que.) General Hospital.

Preparation of Personnel Important In Preventing Infection Spread

The communicable-disease hospital is an archaic concept which is rapidly disappearing from our communities. When it did operate, it cared for infectious diseases and prevented cross-infection with no more facilities than those found in the general hospital today. The outstanding difference between the two is in preparation of personnel. In the communicable-disease hospital, personnel knew their responsibilities and knew the rudimentary technics for prevention of cross-infection.

The general hospital can and indeed must adapt to care for communicable disease. Two principles must be considered when caring for communicable disease in existing facilities: space and quality of personnel. The admitting officer who is aware of the ramifications of care of infectious diseases will admit the patient to a proper area—ideally, a single room with all the facilities for care.

If the decision for admission space is made by an untrained person, the ward nurse must recog-

nize and speak up for the potential hazard of admitting an infected patient to an open ward. A responsible person must consider the potential of infection and outline necessary precautions to prevent spread. No disease can be kept from spreading where crowding exists. Even rudimentary precautions break down in crowded facilities.

There is little logic in the behavior of the physician who enters the precaution unit properly gowned, reaches ino a suit pocket for a watch, takes the patient's pulse, returns the watch to his pocket, removes the precaution gown and leaves the unit.

No matter how conscientious the physician and nurse are, precaution technics will break down if the other personnel are not circumspect. Usually the breakdown occurs because technics are cumbersome and complex. Simplification within limits of the disease should be achieved.—*Louis Weinstein, M.D.,* professor of medicine, Tufts University School of Medicine, and chief, infectious disease service, New England Center Hospital, Boston.

Warns Against Infection Pathways In the Operating-Room Suite

Every operating room should be air-conditioned and have humidity control. It is probably unwise to recirculate air. Air intakes must be inspected. Filtration of incoming air is important, as are regular maintenance of equipment and a bacteriological survey and analysis of air coming through the ducts.

There is no place for visitors in the operating room. Only people with a definite purpose should be admitted, and then only in proper clothing and shoes. Operating-room personnel either stay in the operating room throughout the day or change their clothing when returning after being out of the suite.

The role of the mask is not well understood. Masks are worn to protect the air from contamination with organisms exhaled. The wound should be seeded with as few organisms as possible. Most masks are inefficient and must be changed between cases. All unnecessary chatter of personnel should be eliminated.

Infected personnel should be excluded from the operating room. Provision should be made so that these people are not penalized economically.

Personnel in operating rooms must consider their own hygiene critically. Daily showers are indicated. Personnel should be educated as to the importance of hand scrubbing and the value of mechanical cleansing.

No surgery is done on an infected patient. At least three months must pass after an infection

before a patient is subjected to surgery. The patient should have a shower or bath before surgery. The surgeon should not operate through areas of diseased skin.

Surgical technic can be a big factor in the incidence of infection. The longer a wound is open, the more organisms are acquired. Slowness in surgery is a habit. No person benefits from prolonged surgery. Good technical skill in the surgeon is important.—*H. Taylor Caswell, M.D.,* clinical professor of surgery, Temple University School of Medicine, and surgical chief, Philadelphia General Hospital.

Outlines Measures for Providing Bacteriological Isolation of Patient

Bacteriological isolation of the infected patient is possible and practical for any hospital. Any arrangement that controls ventilation and prevents spread of air-borne bacteria is acceptable. A single room is best, but a cubicle with floor-to-ceiling partitions is also practical. A curtain of ultraviolet radiation across the entrance to the unit can be the fourth boundary and allow the patient to be in contact with the outside world.

If physical barriers are not possible, complete enclosure with ultraviolet radiation will isolate the patient. The barrier should be three inches thick and measure 50 milliwatts per square foot at the floor.

Pre-occupancy disinfection of premises may be necessary to remove dust and soil that accumulate and harbor bacteria. The room should be stripped of curtains, drapes, and unnecessary furniture. Bedding is sterilized in ethylene oxide or covered with clean plastic cases. Furniture, walls, and floors are treated with a detergent-germicide.

Air currents must be controlled to prevent spread of dust and bacteria. An exhaust fan in the window will discharge air from a septic unit to the outdoors. Bacteriologic filters are necessary on air intakes to prevent entrainment of bacteria-laden dust. Ventilating systems must be checked to be sure air from an isolation unit is not being recirculated. The return louver in isolation rooms should be occluded. Ten changes of clean air per hour will reduce the air-borne count 67 percent.

The interchange area for isolation units should include facilities for gowning, cleaning shoe soles, and disinfecting the skin. Thought should be given to organization of supplies so that a minimal number leave the isolation unit.

Food and water service pose no great problems. Food scraps are dumped into polyethylene trash

bags within the unit. Dishes and flatware are delivered directly to a mechanical dishwasher. These machines are usually run at 180° F. — a temperature sufficient for sanitization.

Diagnostic tools and equipment used in the isolation unit are disinfected by wiping them with an alcoholic germicide on leaving the unit.

Bedding is changed daily. Bedmaking should be done with a minimum of flurry to avoid disseminating large numbers of organisms into the air. Soiled bedding is gently rolled off the bed and discarded directly into hamper bags, which are emptied directly into laundry machines without preliminary sorting.

Floors are vacuumed daily to remove dry debris and disinfected with a flood of detergent-germicide which is removed with the wet pick-up. Horizontal surfaces and furniture are damp-dusted with the same germicide.

The patient bathes daily with a germicidal soap or detergent. Shampoos are necessary to decrease the number of organisms retained on hair.

The patient is removed from isolation when cultures of the nasopharynx, hair, fingers, air, and bedding show that the offending bacteria have disappeared. This may be 24 hours after antibiotic therapy is instituted. Prompt removal from isolation is imperative because few patients thrive on solitary confinement and the insidious neglect that accompanies most communicable-disease care. — *Carl W. Walter, M.D.,* associate clinical professor of surgery, Harvard Medical School, and surgeon, Peter Bent Brigham Hospital, Boston.

People Key Factor in Infections, 150 Environmental Studies Show

In environmental studies done in 150 selected clean cases, infection has not been found to be related to any aspect of the environment except people. Methods and products to prevent infection are not convincing; many do cut down on the number of bacteria present, but they do not apparently affect the infection rate.

In our experience, the use of sterile mops, pails, and an iodophor has cleaned and disinfected floors as effectively as the wet pick-up technic. — *Chester W. Howe, M.D.,* associate professor of surgery, Boston University School of Medicine.

Seek Obvious Sources When Infection Appears in Hospital

The first infection appearing in a hospital must immediately alert everyone. The second can be anticipated by figuring incubation periods. Two or three cases are an epidemic and require immediate attention.

The obvious sources should be sought. Does someone on the health team have an infection or a cold? Bacteriology and antibiograms can identify the organism. Staff members with positive nasal cultures of that organism should be banned from the clinical scene, even though they have no apparently active infection.

The infection committee should be at work before any real problem exists. Early definition of the problem means an early solution.

The infected patient has always been recognized as a hazard. Many hospital personnel, however, are not willing to accept the significance of the environment. Yet, historically, the environment keeps recurring as an important element in cross-infection.—*Alexander D. Langmuir, M.D.,* chief, epidemiology branch, Communicable Disease Center, U.S. Public Health Service, Atlanta, Ga.

(Abstract of a paper presented at the 1960 meeting of the American Academy of Orthopedic Surgeons)

Enzyme Therapy Speeds Healing in Infected Orthopedic Wounds

Twenty-one of 30 cases of serious infection following orthopedic procedures were treated successfully with the enzyme fibrinolysin. These 21 cases are especially noteworthy, because of the seriousness of the infections. In many, enzyme therapy was instituted as a last resort, when many other forms of treatment had failed.

Four out of the five patients with a prosthesis replacing the femoral head had complete healing, despite the fact that the prosthesis was, at least in two instances, exposed in the infected wound.

Eleven of the 30 patients had chronic resistant osteomyelitis. Seven healed completely with fibrinolysin and two had secondary surgical procedures when the wounds were clean seven days and 30 days after enzyme therapy was started.

The effectiveness of the enzymes on debridement and healing is almost directly proportional to the age of the infection. The older the wound, the longer it will take to obtain healing. Wounds packed with fibrinolysin at the time of incision and drainage will be found to be clean with pink walls in 24 hours or less. These wounds also heal rapidly. The 30 cases reported here were almost all old, some over a year in duration, and were therefore, in general, resistant to treatment.

Human fibrinolysin as a debriding agent has many advantages. It does not irritate, and does not destroy partially devitalized tissues. Although not as potent as trypsin, chymotrypsin, or papaine, it

has a prolonged activity.—*Eugene E. Cliffton, M.D.*, New York City.

(*Abstract of a talk given at the 1960 congress of the Association of Operating Room Nurses.*)

Repeat Prescribed Routines Often For O.R. Sterility

We believe that most wound infections originate in the operating pavilion; therefore, exacting attention should be given the multiple details of surgical technics, for they are critically important. We believe that sterility in the operating room can be maintained solely by frequent repetition of bactericidal-cleaning processes, isolation by physical barriers from the rest of the hospital, and bacteriologically protective coverage of surfaces which cannot be sterilized.

In our hospital, the described routines are followed regularly and rigidly by everyone. Sterility of floors, walls, and furniture in the operating rooms and corridors, which are exposed constantly to contamination, is attained through scrubbing with a detergent-disinfectant solution, changed frequently during use.

Protection of the environment against contamination by patient and personnel is achieved by placing freshly clean coverings and masks on patients at the door of the interchange area and admitting to the operating room only personnel wearing properly cleaned covering apparel.

Minimum requirements for proper surgical attire are a fitted filter mask, a quick-change wrap-around gown put on freshly clean for each O.R. entry, and bacteriologically protective conductive booties for coverage of shoes. Skin sterilization and isolation are accomplished by a 10-minute scrub plus antiseptic, coverage of personnel with proper masks, sterile gowns and gloves, and isolation of patient's skin with sterilized, transparent, adherent plastic skin drapes.

The clinical effects of this infection-control program are near-total sterility in the operating rooms all day—every day.—*Ralph Adams, M.D.*, chief surgeon, Huggins Hospital, Wolfeboro, N. H.

(*The following material appeared in the "Questions and Answers" department of the May 16, 1959 issue of the* Journal of the American Medical Association, *and is reprinted here with permission of the editors.*)

Q. The chairman of the infection committee in a hospital has been concerned as to what to do with the nasal carriers of coagulase-positive strains of *Staphylococcus pyogenes* var. *aureus* among key personnel of the obstetrics and surgical services. Specific antibiotic therapy based on sensitivity

studies of the organism involved has been recommended. Bacteriophage typing has not been done, as facilities for this service will only accept material from patients with active cases.

Some of the personnel rebel at having to take antibiotics when they feel well. Others cooperate with therapy but never succeed in showing negative results on nasal culture after supposedly adequate courses. Others have a temporary loss of nasal staphylococci but have a relapse.

In a small community where paramedical personnel of all types are at a premium, such persons as delivery-room supervisors or surgical scrub nurses, who cannot be replaced, should not be removed from duty. How important is the role of the nasal carrier? Please give recommendations as to management of nasal carriers in such a situation.

A. The treatment of key personnel who have coagulase-positive staphylococci in the nose and throat does not consist of giving antibiotics. In the event such organisms are there after acute infections, it is logical, either with the properly chosen sulfonamide drugs or with antibiotics, to clear up the residual infection, but in chronic carriers the usual experience is that these organisms disappear while the subject is under therapy, only to reappear within a relatively short time after treatment has been discontinued.

The answer to this problem consists of a return to strict medical aseptic technics. It is largely due to the loss of this factor that hospitals now face the staphylococcus problem. The reliance has been on anti-infective drugs rather than on properly applied aseptic technics.

Such key personnel may continue to be employed as long as they are taught the tenets of medical asepsis, washing their hands thoroughly after blowing their nose, touching their face, or going to the toilet, as well as thorough washing and rinsing at least three times before proceeding from one patient to another.

Type-specific bacteriophage has been used, both as a nasal spray and by intramuscular injection, to clear up the carrier state, and good results have been reported.

Assisted by Dorothy W. Errera, R.N.

Q. We would appreciate an outline for a technic for handling instruments and syringes and needles after a known case of hepatitis.

A. The difficulty with outlining a technic concerned with homologous serum jaundice is that there are no known laboratory tests which are simple enough to use routinely on all patients. Hence, every patient is considered a potential carrier of the virus, and every time blood or tissue fluid contaminates an instrument, that instrument is considered contaminated with the virus and must be terminally sterilized in heat before it is handled.

The incidence of serum and infectious hepatitis is on the rise again,* and all caution possible is indicated to protect personnel and patients. Terminal sterilization in steam at 250°F. for 15 minutes or boiling for 10 minutes is recommended for destruction of the virus.

Q. We have been considering a plan to limit certain types of surgery to certain rooms with the idea of cutting down on cross infection. Do you approve of this scheme?

A. Segregation of various types of surgery, such as you propose, accomplishes little in the control of cross infection because the potential channels for spread by personnel, fomites, air and so on persist.

Control of cross infection in a hospital demands that all operative procedures be accomplished under optimum aseptic conditions. Attainment of this goal implies good housekeeping, proper air conditioning, disinfection of the anesthesia ap-

*The National Office of Vital Statistics reported that the incidence of serum and infectious hepatitis increased from 15,329 cases in 1957 to 16,012 in 1958.

paratus – as well as the conventional aseptic concepts.

Q. What do you think of the use of old newspapers from all over the hospital for lining kick buckets in the operating room?

A. Newspapers often travel from patient to patient indiscriminately and come to rest in the darkest and dirtiest corners of hospital utility rooms. They are often wet, warm havens for insects and bacteria. Kick buckets in the operating room should be lined with waterproof paper bags that will confine waste, both wet and dry, and make safe disposal and handling a reality.

Q. Is it necessary to wear a mask at all times in the operating room even between cases when getting ready for the next? Is it necessary for student nurses to wear masks when cleaning rooms at the end of the operative schedule? Is it necessary to wear masks when stocking the rooms for the following day?

A. Everyone wears a mask at all times in the operating rooms proper. Breathing and talking are full-time activities and with expired air, there are droplet nuclei containing bacteria. These settle out of the air to the floor and other horizontal surfaces. They multiply and are scuffed back into the air by activity and ventilation. Then, they are inhaled by unmasked personnel or settle out on exposed sterile surfaces and so the cycle continues.

Q. Should soiled linen in the operating room be saturated with germicide before going to the laundry?

A. Soaking linen is a sloppy technic – seldom accomplished without contaminating the surrounding environment and the persons involved. Because of the adsorptive properties of many germicides, the technic is not consistently effective in destroying organisms.

Contaminated linen is handled best in the laundry. Any washroom using wash temperatures up to 160°F. and a good wash cycle with built soaps, alkali, sour and germicide can process such linen without any threat to personnel or subsequent loads of laundry. The control begins with collecting all soiled linen in bags which are intact, which are of a size compatible with the opening of wash wheels, which can be snugly closed. The familiar gross canvas bag, riddled with holes and with its contents overflowing, has never been an asset in communicable disease control. In the laundry, soiled linen is dumped directly in the wash wheel. The bag follows. Personnel concerned have to be oriented to the need for protecting washers from contamination with pieces of renegade linen and for protecting themselves with gowns and gloves – the latter also added to the washer after loading.

Q. Would you suggest saturating sponges and waste before incineration?

A. Again, the handling and sorting incidental to preliminary soaking of soiled material only introduces more hazard. Waste is discarded directly into waterproof bags. The latter are closed snugly and either discarded directly into an incinerator or into a covered container which is plainly marked for contaminated material. The porter transporting these containers for incineration should know the potential hazards of his job and be supervised in handling the material. The single use, disposable waste containers offer the ultimate in safety in waste collection and disposal.

Q. Would you describe the technic for culturing the floor?

A. Have your shop make a template of either steel or aluminum. This is a rectangle of metal heavy enough to make good contact with the floor with a 5 cm. opening. Sterilize the template at 250°F. for 30 minutes. Place the template on the floor. Scrub the area within the opening for 30 seconds with a swab moistened in buffer solution. Twirl the swab in 5 cc. of Butterfield's buffer. The bacteriologist then cultures 1 cc. aliquots on nutrient agar pour plates. If cleaning agents containing either hexachlorophene, a quaternary ammonium compound, or iodine have been used on the floor, a neutralizer must be used in testing.

Q. What is the best method of sterilizing dishes from isolation cases?

A. All pathogenic organisms have low thermal death points provided moisture is present. The ordinary hospital dishwasher, run at 180° F., is adequate for sanitizing dishes from a precaution unit. There is hazard, however, in collecting and transporting.

Obviously, dishes from precaution units should not be accumulated in a kitchen or utility room. Food scraps should be discarded in a polyethylene trash bag within the patient's unit. If the dishes and flatware cannot go thence directly into a washer – if only central dishwashing facilities are available, for instance – disposable tableware is more convenient and safer than attempts to improvise disinfection with germicides.

Q. Must the ambulatory patient with a staphylococcal infection use a bedpan where toilet facilities are available?

A. Until cultures of an infected patient's skin, wound, and nasopharynx are negative, it can be assumed (and documented bacteriologically) that the patient is a spreader of dangerous organisms. Unless the toilet is restricted for that patient's use or prompt disinfection of the fixture is possible immediately after use, the patient must endure the indignity of the bedpan.

Q. Handwashing on the ward is seldom more than a brief swipe at the faucet. Can you really believe this is worthwhile?

A. At least, one can assume there is the beginning of a useful reflex.

Personnel, both lay and professional, must first be educated to the importance of conscientious handwashing. This education may be more effective if oriented to self-protection as well as patient care. Running water, mechanical friction, and detergency are the beginning. Thereafter, one can strive to evoke a respect for the germicidal skin degerming agents which will reduce the skin flora to a minimum and discourage the proliferation of transients picked up in the course of patient contacts.

Q. When a ward is not equipped with a sink and running water, what then?

A. Sponges wet with 70 percent isopropyl alcohol provide a tidy way of cleaning hands. For those with more extravagant tastes, use of prepackaged "towellettes" saturated with a quaternary ammonium compound is a good technic. Floor models of liquid soap dispensers can also be located throughout a ward to dispense liquid germicides for cleaning the skin of the hands.

The traditional basin of murky solution should be abandoned. There are too many factors involved that negate the ordinary germicide's action to make this a safe practice. Solution in these basins is usually changed according to a prearranged schedule which has no bearing on dilution or inactivation from repeated use.

Q. What soap do you recommend for cleaning floors?

A. "Soaps" as such are not very good for cleaning because their detergency is poor, and often films are left behind which either support bacterial growth or interfere with conductivity of the operating-room floor. Modern cleaning compounds are built of combinations of soaps and detergents to achieve good cleaning action. In addition to detergency, one can strive for bactericidal and bacteriostatic effect when treating floors in a hospital. The iodophors and substituted phenolics combine these actions with comparable bacteriologic effect.

Q. Which do you feel is more important – changing masks every hour or having the doctors change their street clothes when they come into the operating room?

A. Because cross-infection is due to any combination of factors, it is difficult to ascribe importance to any single factor. Various individual factors may be of importance periodically and at other times, a dozen or more may be involved in the spread of cross-infection. An over-all program is therefore essential. Paradoxically, there can be no

letdown in effort as a program to control cross-infection becomes effective. An analogy is the safety program in which continuing effort must be expended to maintain a perfect record.

There is no "either-or" philosophy in a sincere program for control of cross-infection.

Q. We cannot conveniently flood our operating room floors with germicide but would like to put down blankets saturated with germicide. These would be around the immediate field and at the room entrance. Would this provide enough disinfection for shoe soles?

A. It would make much more sense to institute a program of daily floor sanitization; to limit footwear to use in the operating room; to scrub shoe soles daily with a detergent germicide and to provide ordinary plastic sponge mats immersed in germicide at a few points throughout the suite so that personnel can wipe their shoe soles from time to time with a familiar motion. The wet blanket is a trip hazard; esthetically, it is an eye sore, and it always ends up heaped in a corner.

Q. We have not had a serious infection rate, and our bacteriologist feels that an extensive culturing program in the operating room would be worthless. Do you agree?

A. The floor in the operating room represents the largest single surface on which bacteria accumulate. Floor cleaning and disinfecting are major factors in preventing this accumulation of bacteria, and routine culturing is a valuable aid in monitoring the efficiency of disinfection technics.

Settling plates can be used to measure the fallout of dust-borne bacteria. The Wells air centrifuge can be used to measure total volume air counts, or the floor itself can be cultured. A template is used to isolate a measured area.

Q. Recently we have been asked to use operating gowns made of single-thickness material. Shouldn't the sleeves and fronts of gowns be of at least double thickness, since they are often wet and so close to the wound?

A. Two thicknesses of material will provide a barrier to the transmission of bacteria as long as both thicknesses are dry. Once wet, they are useless. It is important to treat linen with a final germicidal rinse in the laundry so that even when it is wet, the growth and migration of bacteria are inhibited.

Q. Do you feel that the housekeeping department should come under the direct supervision of nursing service?

A. The only way to get clean air in the operating room is to have a clean floor. The nurse must make herself responsible for on-the-spot supervision of porters who clean the operating room floors.

Q. Is suction tubing that is suspended from over the field safe to use?

A. Backflow from suction tubing and contaminated aerosols from suction machines are potential wound contaminants. Suction tubing must always run downhill from the wound so that backflow is impossible. Discharge lines on suction machines must be fitted with changeable filters.

Q. Do you think the postoperative incision should be well covered with gauze and completely sealed with adhesive tape or just lightly covered with one or two strips of adhesive?

A. The best dressing is one that provides a bacterial barrier. A waterproof film that keeps the wound covered, dry, and inaccessible to insects is the best.

Q. Who would you say has the final responsibility for deciding the extent of precautions to be used in a case of sepsis in the private hospital?

A. Infections should be categorized by a professional committee and once the physician classifies the degree of communicability of his particular patient, the precautions outlined are enforced.

Q. The tubing for our suction unit is coiled in a panel in the floor. Is there any danger in using this?

A. Recessed floor panels are difficult to clean, and every time the tubing is unreeled, dirt and bacteria come with it. Also, the operating-room floor cannot be well sanitized unless the surface is homogeneous and unbroken.

Q. Is the ordinary household vacuum cleaner suitable for use in the operating room to pick up dry litter and dust?

A. Exhaust air from most domestic cleaners is a powerful jet that stirs up dust and dirt from the floor. Vacuum cleaners in the operating room should be equipped with diffusers to direct this stream away from the floor and with filters to catch and hold bacteria trapped in dust and dirt.

Q. Our operating rooms are small. We spread sheets on the floor and spread sponges out on them from the buckets into which they have been dropped. There is a minimum of free floor space, and when the sheets are spread down, it is necessary to walk about them or even on occasion, across them. We do a great deal of newborn and infant surgery, and we are requested to keep used sponges within the anesthetist's range of vision, so that blood loss can be observed. Could you suggest an alternative to a sponge rack, considering the size of our rooms?

A. Sponge racks are obsolete. They constitute a bacteriologic hazard of significant import and yield only qualitative information in an area where quantitative knowledge is essential.

Sponges can be collected in waterproof paper bags. The bags can be mounted on an ordinary scale so that blood loss can be measured quantitatively to some degree of accuracy. If bags of sufficiently heavy paper are used and the top edge is cuffed over, it is possible to drape used sponges about the periphery of the cuff until 10 or 20 have accumulated. At that time, the scale can be read and the sponges tipped into the bag by folding up the cuff, and the unit can be set aside for checking, should a discrepancy be discovered during the course of the closure.

This technic prevents contamination of the floor, gives the anesthetists quantitative information concerning blood loss, and is bacteriologically and esthetically sound.

Several experiments using your particular kind of sponge will give you information as to the tare weight of dry sponges and sponges moistened with saline, so that you can determine the net amount of tissue fluid and blood absorbed by the sponges. Many surgeons have abandoned the use of saline sponges in the operating field, realizing that a dry sponge is instantly moistened with blood and hence presents a physiologic surface.

Q. I presently work in a surgical suite where shades are used at all the windows. This is the first time I have seen shades used in the O.R., and I suspect them to be a source of contamination.

A. Window shades are difficult to clean, and every time one is raised or lowered, dust clouds result which are accompanied by free fall-out of bacteria. If sunshine is a problem in an operating room, there are better solutions to the problem.

Q. Should a case considered contaminated or dirty in the operating room be admitted to the clean recovery room? It has been our policy to return such cases directly to the floor.

A. The first consideration is safety for the patient. If concentrated nursing care is not available for the postoperative patient in his own room, then recovery-room care should not be sidestepped.

The environment can be protected from heavy contamination. A waterproof, occlusive dressing applied at the end of surgery will contain the greatest source of dangerous organisms. If single room facilities are not available in the recovery room, the patient is placed in a curtained cubicle, in a bed or litter made up with fresh linen. For the rest of his stay in the recovery room, the linen should be changed only if absolutely necessary.

Transmission of infection is controlled as in any other communicable disease, with meticulous hand hygiene, dressing technics designed to protect personnel and the environment, careful disposal of excreta, terminal sterilization in heat of instruments and equipment, and so forth. When

the patient is discharged from the recovery room, the floor in the area of his bed is sanitized with a detergent-germicide. Cubicle curtains are carefully removed for laundering, and the bed sanitized with a detergent-germicide or live steam.

Q. Our laboratory technician is reluctant to run cultures on our sterilizer because he claims the equipment he has is inadequate. I noticed he has an incubator that goes to 60° C. He also wants to know why he has to use the spore strips we buy for testing. He maintains the cost of the procedure is prohibitive.

A. Spores of *B. Stearothermophilus* are used for testing sterilizer efficiency because this is one of the most heat-resistant organisms available. Spore strips populated with about 100,000 organisms may survive exposure to saturated steam at 250° F. for five minutes but are destroyed in 12 minutes. The spore strips are not difficult to use. The maximum incubator temperature required is 55° C., and only standard laboratory materials such as fluid thioglycollate medium and ordinary culture tubes are used. In the hands of a cooperative bacteriologist it is not a complicated matter.

Cultures must be incubated for seven days. Hence, bacteriological testing, while useful as a spot check on sterilizer efficiency, has little relation to day-by-day safety. Safe sterilization depends on proper packaging in permeable wrappers, proper loading of the sterilizer to allow for free access of steam to all surfaces, and a 30-minute sterilizing cycle.

Q. Will incineration destroy bacteria completely on contaminated materials such as paper or swabs, or must they be autoclaved first?

A. Incineration is the ultimate in terminal sterilization. It is a totally destructive process. Care must be taken to discard contaminated articles for incineration, so that spread of organisms is impossible while the material is being transported to the incinerator. Collection should be in waterproof paper bags or plastic bags, both with snug closures.

Q. Should gloves be destroyed after a septic case? It isn't possible to position them properly in an autoclave when cleaning up after a case.

A. Terminal sterilization of gloves is possible because they are wet when placed in the sterilizer. Gross soil is rinsed from the gloved hands in the glove basin. Gloves are peeled off the hands to avoid contaminating the skin and are left in the glove basin. The scrub nurse squeezes out excess water before she arranges them in sterilizing trays for terminal sterilization. The gloves are wet throughout, and as they are heated the moisture in folds and creases is turned to steam.

Q. Should sterile supplies on a window sill or in

an open cabinet in a room in which a septic case has been done be autoclaved before use in another case?

A. Bacteria are present in moisture—sputum, pus, body discharges, contaminated solutions, and so forth. Splashing is an obvious source of contamination of supplies. Bacteria are also present in dust, lint, and dirt particles. They are not present in the air itself, but air currents are the vehicle for transporting bacteria when they are disturbed from surfaces on which they have settled.

In a clean operating room where floors are sanitized daily; where soiled sponges are discarded into proper containers rather than to the floor; where pus and body fluids are contained in suction systems, and where activity and conversation are kept at a minimum, wrapped sterile supplies in cabinets or on shelves at the periphery of the room can be considered safe for use in subsequent cases.

A frequently unsuspected hazard is the enthusiastic "damp duster" who may inadvertently include the bottoms of sterile packages in a swipe at a shelf.

Q. The orderly transporting patients from wards to surgery is a problem because it is not practical for him to change clothes and shoes before and after every patient.

A. The transportation orderly's route ends with entry to the recovery room or interchange area. The hospital bed or stretcher is not taken into the operating room proper. The patient is transferred to the operating table in the recovery room or interchange area and wheeled to the operating room. The table's casters are cleaned daily with a sanitizing detergent, and personnel working between the two areas disinfect the soles of their shoes many times daily so that tracking of dirt is minimized.

A large mat, wet with germicide, recessed in the floor at the entrance to the operating-room suite, is positioned so that rolling equipment and transient personnel must pass over its surface. This limits very effectively the amount of hospital dirt tracked into the suite. [*This technic is illustrated in a 16-mm sound film, "Hospital Infection Control," reviewed in the article beginning on page 201—ED.*]

Q. Our anesthesiologist would like to know why we cannot run blood and glucose at the same time.

A. It is important to avoid contact between dextrose and red cells which have been stored in a blood bank, because on contact with dextrose the red cells take in water and become spherocytes. Such cells are immediately scavenged by the spleen and hence do not remain to benefit the recipient. Slightly hypertonic saline solution is less harmful than dextrose.

Contact between blood and any electrolyte solution has the same effect as exposing the blood to the dialyzing membrane in an artificial kidney, in that there is immediate exchange of ions and water which is deleterious to the stored red cells.

Q. How do you recommend cleaning distilled-water carboys?

A. Properly installed carboys are positioned so that residual water is never left behind to pool. They are drained every day, dried with a heat lamp, and never cleaned.

If carboys are used in the conventional upright position, clean them well with a non-ionizing detergent, using a copious amount of hot water, and be careful to avoid introducing lint from cleaning cloths. Invert the carboys and drain them well.

Q. Most of our topical solutions are prepared in jars with screw caps or in old IV bottles. Are these satisfactory for operating room use? How long should the gallon jugs be sterilized? With this type of cap, how long can the contents be considered sterile?

A. When sterilizing solutions in gallon jugs, sufficient time must be allowed for the jug and its contents to come to sterilizing temperature. A 2,000-cc. Pyrex flask is heated to 250°F. in about 20 minutes after sterilizer's exhaust-line thermometer has reached 250°F. A thick-walled gallon jug such as you describe would need about 45 minutes to heat.

There is no positive way of determining this except with a thermocouple. Hence, the sterilizing cycle for the jugs might be assumed to be 60 minutes at 250°F. That allows 45 minutes after the exhaust-line temperature has reached 250°F. for the jug and its contents to heat to 250°F. and 13 minutes exposure for destruction of organisms.

Q. Is it imperative that procaine solution be put up in dark glass bottles?

A. The choice of container for procaine solution is critical, but is related to the pH of the solution rather than photosensitivity. Alkaline solutions of procaine deteriorate so rapidly that they cannot be sterilized or stored. Hence, solutions must be maintained on the acid side. To avoid the development of an alkaline pH at the solution-glass interface, one must use a "hard" glass bottle – a bottle made of borosilicate glass which does not leach, in contrast to a "soft" glass bottle made of sodium, calcium or lead glass from which alkali is leached.

Dark glass containers for solutions are a hazard because changes of color indicating decomposition of the solution cannot be detected, nor is gross contamination evident.

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By Dorothy W. Errera, R.N.

Infections

Kass, Edward H., and Sassen, Harold S.: "Prevention of Infection of Urinary Tract in Presence of Indwelling Catheters - Description of Electromechanical Valve to Provide Intermittent Drainage of the Bladder," *J. A. M. A.* 169:1181, March 14, 1959.

There hardly breathes a doctor or nurse alive who at one time or other has not taken refuge in the far recesses of the linen closet when the possibility of assembling tidal drainage presented. In this article, the authors describe a motor driven timer which actuates a solenoid-operated valve to control fluid discharge from the bladder.

They begin with the premise that to prevent infection, after insertion of an indwelling catheter, the bladder must be constantly rinsed with an antibacterial solution to prevent multiplication of bacteria. In their experience, a 0.25% acetic acid solution, kept at a flow so that pH of urine is kept at five or less, and the bacterial count less than 100,000 bacteria/cc., has been very satisfactory. The latter count is done by a microscopic examination of a stained drop of uncentrifuged effluent. If no bacteria are seen, it can be assumed there are less than 100,000/cc. This can be substantiated with more formal bacteriological technics of culturing and plating.

They employ a triple lumen catheter—one for inflating the retaining balloon and one each for inflow of irrigating solution and outflow of urine. To ward off the hypotonic, irritable bladder that is contracted and has a painfully small volume after two or three days of constant drainage, they incorporate the outflow tube in the clamp of the automatic guard. When there is no electrical current on, the switch is open and drainage goes on unimpeded; when the current is on, the clamp shuts; no urine escapes.

The cycle of filling and emptying can be adjusted to the patient's particular bladder performance. The device is hooked on the bed, is noiseless and safe because in case of any failure, the clamp opens automatically; urine drains freely.

Davies, D. M.: "Staphylococcal Infections in Nurses." *Lancet* 1:644, March 19, 1960.

In a 12-month period at the London Hospital, 146 of the 725 nurses on duty reported staphylococcal infections. In this period, 16 percent of all admissions to the nurses' sick quarters were for staphylococcal infections whereas the average was 18.2 percent for the entire six years preceding. Working days lost totaled 1249, an average of 8.5 days a girl.

All infections were of the skin or soft tissues (29 percent finger infections). Ninety-eight percent were penicillin-resistant; 33 percent were resistant to tetracycline, and four percent to chloramphenicol.

MacPherson, C.R.: "Oxygen Therapy — an Unsuspected Source of Hospital Infections?" *J.A.M.A.* 167: 1083, 1958.

An apparently well-organized, clean, efficient oxygen-therapy service in a large teaching hospital was investigated to either confirm or deny the likelihood of contaminated oxygen-therapy apparatus.

Attachment and pressure-release valves were essentially sterile; delivery tubing for the patient was clean, showing only an occasional *S. albus* or diphtheroid; *but* water reservoirs and oxygen inlet and outlet ducts were heavily contaminated.

Distilled water was heavily contaminated. It was discovered that the distilled water carboy was not regularly cleaned or disinfected, and distilled water only one day old contained as many as 2,000 organisms per milliliter. The siphon used to withdraw water from the carboy was contaminated; the water bottle used for replenishing units and the residual water in units were similarly loaded with bacteria.

Organisms were primarily nonpathogenic, but the dangerous contaminants present were sufficiently awesome to inspire a clean-up program. These rules are now followed:

1. All water used in humidifying equipment is dispensed from sterile flasks of sterilized distilled water.

2. Apparatus is changed after one week of use.

3. Humidifiers are completely emptied each time before replenishing.

4. Glass reservoirs are cleaned and disinfected terminally after one week of use.

5. Rubber washers are replaced as soon as signs of wear are noted.

6. All heat-stable parts are autoclaved terminally and after a week of use.

7. All apparatus is cleaned, disinfected and dried before storage and protected from dust and air-borne contamination while in storage.

8. Disposable tubing is used wherever possible.

9. Bacteriological monitoring is routine.

Chemical disinfection of outlet ducts on the humidifiers was less than satisfactory, and old units are being replaced with models which will withstand steam sterilization.

U.S. VA Cooperative Study Committee for Hospital Infections: "An Evaluation of Hospital Infections with Analysis in Mortality

and Morbidity." *Surg., Gynec., and Obs.* 110:157, February, 1960.

This notable study defines the severity of the community and hospital infection problems and illuminates certain inadequacies in reporting and controls.

Patient populations in six hospitals were studied for 18 months. Two of the six were tuberculosis hospitals; one was a 150-bed general hospital in a small New England community, and one a 500-bed general hospital in a university city. The last two were 1,000-bed general hospitals in metropolitan areas and with university affiliation.

A central laboratory was established to standardize laboratory technics and assure a more reliable spectrum of results. Until the technics were reconciled and supervised, results between individual hospital laboratories and the reference laboratory agreed in only 86 percent of all instances. With uniformity of technics, results now agree in 99 percent of cases.

Type 42B/52/52A/81 was found in 19.3 percent of the cultures; a new strain, 47/77/54/53, made an increasingly frequent appearance, until it now accounts for 17 percent of cultures; and type 80/81 is making a return appearance. This changing pattern of infectivity is quickly recognized in a centralized reference laboratory, whereas the individual hospital laboratory may not detect such a change until valuable time for control has been lost. The reference laboratory with data available is in a position to suggest schedules for enforced removal of effective antibiotics from clinical areas before resistance is established.

In this study, any clinical condition yielding a pure culture of staphylococci or one in which the staphylococci were predominant was tagged an infection. These ranged from inflammation to meningitis and septicemia.

Great variations in reporting existed between hospitals despite the development of a standard form. Differences of opinion and a philosophy that did not consider the potential hazard to other patients of the minor infection in a host were considered to be the causes of variations.

In one large hospital, a particularly conscientious physician personally ferreted out all infections for several months. The infection rate for that time swung between 13 and 15 percent. When he was transferred, the reported rate dropped to one to two percent, at which level the hospital had supposedly been operating before the study.

This experience provoked a thorough hospital-by-hospital, bed-by-bed study by members of the investigating group.

Seventeen percent of the patients in the tuberculosis hospitals were suspected of infections other than tuberculosis; 37 percent of the patients in the general hospitals (evenly divided between medical and surgical services) warranted further study. Significant numbers of infections were found in patients hospitalized for other disabilities or diseases.

In the 18 months of study, 29,817 patients were hospitalized, of whom 1,093 had infections due to staphylococci. About half of these acquired their infections in the hospital, and about half were admitted with infection already present. One-hundred fifty-one died with clinical infections, and staphylococcal infection contributed to 95 of the deaths (63 percent). Thirty-two deaths were in patients with infections acquired in the community; 52 were in patients with hospital-acquired sepsis. Eleven cases could not be placed definitely in either category.

Every hospital has an individual infection problem, and a plea is made for high-level professional supervision. Infection committees are urged to make rounds from bed to bed to honestly identify and assess infections, so that realistic data can be established whereby an epidemic can be announced or control measures can be evaluated for effectiveness.

Spiner, David R., and Hoffman, Robert K.: "Method for Disinfecting Large Enclosures with B-Propiolactone Vapor." *Appl. Microb.* 8:152; May 1960.

Disinfection of large areas with liquid disinfectants is tedious, and the results may be uncertain because great expanses of surfaces are difficult to handle when uniform application is necessary. Corrosion and damage to finished surfaces are also unpleasant sequelae.

A gaseous germicide which would permeate a whole area would be ideal if it could be contained in that area long enough to sterilize. It should leave no deposits or residues on surfaces and should be noncorrosive.

Beta-propiolactone appears to fill these latter requirements and its vapors have been shown to be sporicidal, bactericidal, rickettsidal, virucidal. It has been used to disinfect a two-story army barracks; a furnished hospital room with wall-to-wall carpeting, furniture, books, television, etc.; and a surgical suite.

Its efficiency was measured by planting spores of *B. sub-*

tilis var. *niger* in 31 locations throughout a ward. After two hours exposure to the chemical vapors, only one sample remained unsterile and the contamination level on that one has been reduced 99.99 percent.

The chemical is toxic and rigid precautions are essential.

The commercial grade lactone which contains 97 percent BPL is recommended because it is cheaper than purified grades and is non-flammable and non-corrosive. The chemical is stored at refrigerator temperatures in chemically clean containers to prevent the formation of residue-producing agents.

The room or area to be disinfected need not be air-tight but large cracks should be sealed off with tape. Ventilating and air-conditioning systems are shut off and adjoining rooms are protected from seepage of the chemical. There should be a separate means for ventilating the area after treatment. Cabinets and drawers are opened. Electric fans placed around the room help to circulate the vapors.

The vapors must be maintained above 75° F. and the relative humidity at 70 percent at least. The level of relative humidity is more critical than temperature and below 70 percent, efficiency decreases rapidly. A vaporizer can be used to maintain humidity or a continuous fine spray may be necessary.

Concentration and exposure are important. Two to four milligrams of BPL are used per liter of air for two hours. If a room has many absorptive surfaces – rugs, drapes, overstuffed furniture – more chemical is needed. For an ordinary laboratory, one gallon for 16,000 cubic feet is adequate; for a furnished room one gallon is used for 12,000 cubic feet.

A commercial insecticide spray is good for dispensing the chemical. The spray must be fine so that there is no "raining." An inefficient spray or too high concentration of chemical will result in vapor condensate which can be destructive to some surfaces.

If an electric powered atomizer is used, it can be located in the room and controlled from outside with a master switch.

After two hours, doors and windows are opened. Care must be taken to see that vapors are not exhausted into adjoining rooms. A day of aeration is usually adequate; if ventilation is forced, less time is necessary. The room is ventilated until the odor is gone or is unobjectionable.

Toxic levels were measured in mice. The chemical is very

irritating at a concentration just above detectable limits and below the acute toxic level. So in a sense, it can be its own warning device. When no discomfort is experienced in the presence of residuals of vapor, it can be considered safe. A chemical test is also possible.

Personnel involved in routines with the chemical should wash well after each procedure to avert possible skin irritation. Repeated exposure should be avoided because there is a possible carcinogenic factor.

If it is necessary to enter a room before it has been completely aerated, a gas-mask with charcoal canister and gas-impermeable clothing tied at wrists and ankles must be worn. Each exposure should be limited to a few minutes. Outer clothing should be removed promptly after exposure and replaced with clean clothing after a thorough cleansing shower.

Foster, W. D.: "Environmental Staphylococcal Contamination – a Study by a New Method." *Lancet* 1:670, March 26, 1960.

Slabs of agar reinforced with gauze are used as impression plates to measure contamination of the floor. A strip of gauze bandage 1.5" wide is placed across an empty Petri dish. Nutrient agar is poured over the strip, and when it is stiff, the "disc" is removed with forceps. The under-surface is pressed firmly on the floor, and the disc is returned to the lid of the Petri dish with the contaminated side uppermost.

The technic was used to demonstrate the degree of environmental contamination by a patient with but a slight infection. Such a patient with a small patch of impetigo was admitted to an empty three-bed ward which had been previously disinfected. Twenty-four hours after admission, blood agar settling plates were exposed for 30 minutes around the patient's bed. Averages were three colonies per plate of staphylococci and 0.5 colonies per plate of *Streptococci pyogenes.*

Impression plates of the floor in the vicinity of the patient's bed – made at the same time as the settling plates –showed significantly higher counts (24 to 40 colonies per plate). The plates were also used to demonstrate the bactericidal efficacy of routine floor disinfection.

In an all-out campaign to control environmental contamination, damp dusting with chlorhexidine replaced dry dusting and became a regular part of housekeeping routine along with daily floor disinfection. In 12 consecutive weeks, no organisms were recovered from the floor.

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